VOL. 75, NO. 3 JULY, 1941

THE PHILIPPINE JOURNAL OF SCIENCE

IMPERIAL MYCOLOGICAL INSTITUTE
17 NOV 1941

MANILA
BUREAU OF PRINTING
1941

54691

DEPARTMENT OF AGRICULTURE AND COMMERCE

BENIGNO S. AQUINO, *Secretary*

JOSÉ S. CAMUS, *Under Secretary*

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, Philippines, as second-class matter.]

A. S. ARGÜELLES, D.Sc., *Editor*
EDUARDO QUISUMBING, PH.D., *Associate Editor*
EDUARDO R. ALVARADO, A.B., LL.B., *Managing Editor*
SOPHIE RODOLFO, M.A., *Copy Editor*

Chemistry

MANUEL L. ROXAS, PH.D.; A. P. WEST, PH.D.; T. DAR JUAN, PHAR.D.
JOAQUIN MARAÑON, D.SC.; PATROCINIO VALENZUELA, PH.D.
MARCOS M. ALICANTE, PH.D.; F. T. ADRIANO, PH.D.; R. H. AGUILAR, CH.E.
A. J. HERMANO, D.SC.; V. G. LAVA, PH.D.; J. C. ESPINOSA, B.S.
MARIA Y. OROSA, M.S.

Geology

Q. A. ABADILLA, E.M.; V. ELICAÑO, B.S.; JOSÉ M. FELICIANO, PH.D.
ANTONIO D. ALVIR, PH.D.

Experimental Medicine

DANIEL DE LA PAZ, M.D.; H. W. WADE, M.D.; ARTURO GARCIA, M.D.
ONOFRE GARCIA, M.D.; CRISTOBAL MANALANG, M.D.
ISABELO CONCEPCION, M.D.; VICTOR BUENCAMINO, D.V.M.

Clinical Medicine

ANTONIO SISON, M.D.; LIBORIO GOMEZ, M.D., PH.D.
JOSÉ ALBERT, M.D.; H. LARA, M.D.
JOSÉ RODRIGUEZ, M.D.; CARMELO REYES, M.D.

Botany

ELMER D. MERRILL, D.SC.; E. B. COPELAND, PH.D.; J. K. SANTOS, PH.D.
A. F. FISCHER, C.E., M.F.; T. G. FAJARDO, PH.D.
RAFAEL B. ESPINO, PH.D.; NICANOR G. TEODORO, PH.D.
JOSÉ B. JULIANO, PH.D.; FELICIANO M. CLARA, PH.D.

Zoölogy

HILARIO A. ROXAS, PH.D.; MARCOS A. TUBANGUI, D.V.M.
LEOPOLDO B. UICHANCO, D.SC.; HERACLIO R. MONTALBAN, M.A.
GONZALO MERINO, PH.D.; FAUSTINO Q. OTANES, M.S.
MANUEL D. SUMULONG, M.S., D.V.M.; LOPE M. YUTUC, D.V.M.
DEOGRACIAS VILLADOLID, PH.D.; CANUTO G. MANUEL, D.SC.

Anthropology

H. O. BEYER, M.A.; E. E. SCHNEIDER, B.L.
RICARDO E. GALANG, M.A.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 75 JULY, 1941 NO. 3

REDUCING THE ACIDITY OF MANILA COPAL

REACTION OF RUN COPAL AND GLYCEROL

By GLORIA D. MANALO and AUGUSTUS P. WEST
Of the Bureau of Science, Manila

ONE TEXT FIGURE

Natural resins are obtained as exudations of forest trees. They have been used for years in making high-grade varnishes. The copals are the most important of the natural resins. There are two general classes of copals, Congo and Manila. The Congo variety is obtained from the Congo district in Africa, while the Manila product comes from the Netherlands East Indies, the Malay States, and the Philippines.

In preceding reports [1] from this laboratory methods were given for analyzing and refining Manila copal, which was found to consist mostly of resin acids together with some terpenes, resenes, and material insoluble in alcohol. The insoluble matter is usually composed of gelatinous material together with foreign impurities. Oxidation of the copal apparently precedes the formation of the gel.

Soft Manila copal dissolves readily in alcohol, with the exception of the foreign matter and gelatinous material that may be contained in it. It is not soluble in drying oils, such as linseed oil. In order to make oil varnishes with this resin it is customary to heat it until the water, terpenes, and volatile decomposition products have been removed. This heating process is known in the varnish industry as running.

[1] Tanchico, S. S., and A. P. West, Philip. Journ. Sci. 73 (1940) 259, 285; Manalo, G. D., and A. P. West, Philip. Journ. Sci. 74 (1941) 157.

Several investigations [2] have indicated that some of the acids in Manila copal are dibasic. When the resin is run (heated) at a temperature of about 300° to 310°C. to remove volatile constituents, the dibasic acids are converted to monobasic, thus reducing the acidity of the copal.

Samples of run Manila copal were recently prepared in this laboratory and a method [3] was devised for analyzing them. The composition of the copal was then determined before and after running. The results showed that the acidity of the natural copal was considerably reduced by running, but the run copal still had an acid number varying from 67 to 109, depending on the sample.

Due to the acidity of the copal, varnishes made with run copal tend to liver or solidify when mixed with basic pigments, like zinc oxide, to make enamels.

According to Barry [4] the Congo copals, after running, may be esterified on a commercial scale by neutralizing the resin acids with glycerol. The resulting ester is soluble in linseed and other vegetable oils. Varnishes made from the ester have the advantage of a low acid number and resistance to alkalies. Moreover, the varnish films have a hardness and durability of superior quality. It has been reported [5] that Manila copal may also be esterified, but in the literature we found no details of this process.

Recently we investigated the interaction of glycerol and Manila copal. We obtained a product that had not only a low acid number but also a low ester number. It probably consisted mostly of polymerized bodies. However, it proved to be excellent for making durable high-grade varnishes and enamels. Our experiments along this line have therefore consisted principally in determining a suitable procedure for reducing the acidity of Manila copal with glycerol.

EXPERIMENTAL PROCEDURE

The Manila copal used in this investigation was collected by forest rangers and kindly presented to us by Director Tamesis of the Philippine Bureau of Forestry.

[2] Wolff, H. Farbenztg. 29 (1924) 2039.
Horrmann, P., and N. Kroll. Arch. Pharm. 265 (1927) 214.
Ruzicka, L., and J. R. Hosking. Ann. 469 (1929) 147.
[3] Intengan, C. L., and A. P. West. Philip. Journ. Sci. 75 (1941) 83–95.
[4] Ind. Chem. and Chem. Manuft. (1938) 319.
[5] Ellis, C. The Chemistry of Synthetic Resins 1 (1935) 807, 817.

A number of preliminary experiments were carried out to ascertain the most appropriate conditions for reducing the acidity of Manila copal. First, the copal was run (heated) at a temperature of 315° to 325°C. This process is carried out by gradually melting the copal and continuing to heat it until gases are no longer evolved and the mass subsides and boils gently. The time required to reach this stage is about 1.5 hours, although it varies with the quantity and the sample of copal used. After this condition is reached, heating is continued for about 1.5 hours longer. By heating the copal somewhat above 310°C. the time required to complete the running is reduced. In this running process the temperature is measured by a thermometer inserted into the molten copal.

The acid number was determined both before and after running, by treating approximately 1 gram of the powdered copal with 50 cubic centimeters of a mixture consisting of neutral absolute alcohol and benzene (25 cubic centimeters each) and titrating directly with seminormal alcoholic potassium hydroxide in the presence of phenolphthalein.

Data on the run copal are given in Table 1.

TABLE 1.—*Results of running (heating) Manila copal (decrease in weight and acid number).*

Sample.	Weight.			Acid number.		
	Before running.	After running.	Decrease.	Before running.	After running.	Decrease.
	g.	*g.*	*Per cent.*			
41	150	120	20	133.92	81.37	52.55
42	200	150	25	130.99	79.16	51.83
43	100	85	15	131.60	87.33	44.27
44	150	128	15	107.14	79.49	27.65
45	200	150	25	131.69	76.79	54.90
46	150	120	20	134.97	88.57	46.40
47	100	85	15	106.21	71.96	34.25

NOTE.—The copal was run (heated) at a temperature of 315° to 325°C. for 3 hours.

The loss in weight resulting from the running process varied with the different samples from 15 to 25 per cent. A decrease in the acid number varying from 27.65 to 54.90 was also noted.

Experiments to reduce the acidity of the run copal were carried out, with the use of glycerol as the neutralizing agent. This reaction was facilitated by the presence of a catalyst. Various catalysts were used in preliminary trials. Zinc dust gave the best results.

In Table 2 are given some results on the interaction of run copal and glycerol. Zinc dust was used as catalyst. The samples used and the experimental conditions for running the copal were the same as those reported in Table 1. Accordingly the acid numbers of the run copal (Table 2) were not actually determined, as they were assumed to be the same as those recorded in Table 1.

Immediately after running the copal, glycerol and zinc dust were added and the heating continued for 3 hours more at a temperature of 290° to 295°C. The glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal. After these experiments the acid number was ascertained by dissolving about a gram of the reaction product in 50 cubic centimeters of neutral benzene and titrating the solution with one-tenth normal alcoholic potassium hydroxide. The dilute alkali solution was selected, because the reaction product of glycerol and run copal has a comparatively low acid number.

TABLE 2.—*Reducing the acidity of run Manila copal with glycerol and zinc dust catalyst.*

Sample.	Ingredients.			Acid number.	
	Run copal.	Glycerol.	Zinc dust.	Run copal.	After reaction with glycerol.
	g.	*g.*	*g.*		
41—A	120	12.0	0.60	81.37	16.31
42—A	150	15.0	0.75	79.16	15.42
43—A	85	8.5	0.42	87.33	18.44
44—A	128	12.8	0.64	79.49	13.60
45—A	150	15.0	0.75	76.79	13.68
46—A	120	12.0	0.60	88.57	24.92
47—A	170	17.0	0.85	71.96	10.13

NOTE.—The copal was first run at a temperature of 315° to 325°C. for 3 hours and then immediately treated with 10 per cent glycerol and 0.5 per cent zinc dust catalyst and heated at 290° to 295°C. for 3 hours. The samples (41—A to 47—A) used for these experiments were portions of those (41 to 47) recorded in Table 1.

The acid number of the run copal was greatly reduced after treating with glycerol and the catalyst. In sample 47—A the acid value was reduced from 71.96 to only 10.13. According to Ellis [6] a copal (ester) that has an acid number less than 20 gives satisfactory varnish films that show good resistance to alkalies and are reasonably compatible with basic pigments.

To ascertain if a smaller amount of glycerol could be used for reducing the acidity of run copal, experiments were made

[6] Chemistry of Synthetic Resins 1 (1935) 819.

with varying proportions of glycerol. The sample of run copal employed for these tests was 47—A (Table 2) which had an acid number of 71.96. Calculated on this figure 100 grams of the run copal would require only 3.93 grams of glycerol to neutralize the free resin acids.

The results, recorded in Table 3, show that the lowest acid number (10.13) was obtained when the amount of glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal.

TABLE 3.—*Reducing the acidity of run Manila copal with different proportions of glycerol.*

Glycerol. Grams.	Acid number of reaction product.
3.93	40.38
4.32	29.65
4.71	27.50
5.11	25.14
5.50	23.25
5.89	20.69
6.68	16.14
7.07	16.26
8.05	11.03
10.00	10.13

NOTES.—For every 100 grams of run copal used the amount of zinc dust was 0.5 gram and the weights of glycerol were those recorded in the present table.

Temperature for running copal, 315° to 325° C.
Duration of running, about 3 hours.
Acid number of run copal, 71.96.
Temperature for glycerol reaction, 290° to 295° C.
Duration of glycerol reaction, about 3 hours.

Additional experiments were carried out to ascertain the most suitable conditions for reducing the acidity of run Manila copal to a very low figure. Both the time of running and the duration of the interaction of run copal and glycerol were varied. The data are recorded in Table 4. In these experiments the amount of zinc dust used was 0.5 per cent and the glycerol 10 per cent of the weight of the run copal, except in the reaction with sample 67, when it was 13.33 per cent.

For samples 47—A, 61 to 64, and 67 to 69 inclusive, the temperature of running was 315° to 325° C., and for the glycerol reaction, 290° to 295° C.

For samples 65 and 66 the temperature for running was 310° to 315° C., and for the glycerol reaction, 250° to 260° C.

Samples 47—A and 61 to 69 lost 15 per cent of their weight on running.

TABLE 4.—*Reducing the acidity of run Manila copal by varying both the duration of running and the reaction with glycerol.*

Sample.	Time.		Ingredients.			Acid number of reaction product.
	Running.	Glycerol reaction.	Run copal.	Glycerol.	Zinc dust.	
	Hrs.	*Hrs.*	*g.*	*g.*	*g.*	
61	3.5	3.0	510	51	2.50	5.08
62	3.5	3.0	900	90	4.50	7.21
47–A	3.0	3.0	170	17	0.85	10.13
64	3.0	3.0	170	17	0.85	7.44
65	4.5	2.0	50	5	0.25	7.86
66	4.5	2.0	50	5	0.25	6.88
67	3.0	1.5	128	17	0.60	4.99
68	3.5	1.0	120	12	0.60	6.13
69	3.0	5.0	120	12	0.60	8.69
70						12.02

NOTES.—For samples 47—A, 61 to 64, and 67 to 69 the temperature of running was 315° to 325° C.; and for the glycerol reaction, 290° to 295° C.

For samples 65 and 66 the temperature for running was 310° to 315° C.; and for the glycerol reaction, 250° to 260° C.

Carbon dioxide was passed through sample 64 during both the running and the glycerol reaction; and through sample 66 during the glycerol reaction only. The use of carbon dioxide was expected to give a reaction product light in color. However, the results were about the same as in the other experiments, except that a slightly lower acid number was obtained.

Samples 47—A, 61 to 64, and 67 and 68 were from Tayabas Province; samples 65, 66, and 69 came from Palawan; sample 70 was an imported ester gum.

The data for sample 47—A are also given in Tables 2 and 3.

A review of the results we have obtained (Tables 2, 3, and 4) appears to give the following general conclusions.

In running the copal, before reacting with glycerol, the results are about the same, whether the temperature is 315° to 325° C. for about 3 hours, or 310° to 315° C. for about 4.5 hours. However, it is very important to run the resin thoroughly so as to remove all volatile products.

During the interaction of run copal and glycerol the temperature may be varied from 260° to 290° C. for about 2 hours.

Suitable proportions for the reacting constituents are approximately as follows:

Run copal	100.0 parts
Glycerol	10.0 parts
Zinc dust	0.5 part

These observations are based upon copals we investigated. Since different samples vary considerably in composition, the

formulation of general rules is dubious. For instance, we found that the time required to complete the reaction of run copal with glycerol varies from about 1 to 3 hours, depending on the sample.

The glycerol-copal reaction product we obtained was dark brown, very brittle, and transparent. It was soluble in benzene, turpentine, and oils; insoluble in alcohol, ether, chloroform, and alcohol-benzene mixture.

Oil varnishes were made from run copal and also from the glycerol-copal reaction product, the same formula and procedure being used for both preparations. The glycerol-copal varnish was superior to the varnish made from run copal in that it gave a harder, more brilliant and elastic film. It was also more resistant to alkalies and could be mixed with basic pigments, like zinc oxide, without livering or solidifying.

In reacting the copal with glycerol in the presence of a catalyst we obtained a substance with a low ester number; the one from sample 47—A (Table 2) had the constants given below:

Glycerol-copal reaction product:

Saponification No.	26.11
Acid No.	10.13
Ester No.	15.98

These data indicate that the glycerol-copal reaction product contains only a small amount of ester. To find out more about this product we followed a procedure somewhat similar to the method [7] employed for analyzing run copal.

Another sample of the glycerol-copal reaction product (71—B) was prepared as indicated below:

Manila copal (71)
Acid No. 106.02
↓ Heat at 310°–315° C. for 4.5 hours.
Run copal (71—A)
Acid No. 84.27
↓ Add 10 per cent glycerol and 0.5 per cent zinc dust. Heat at 285°–290° C. for 3 hours.
Glycerol-copal reaction product (71—B)
Sap. No. 25.56
Acid No. 7.83
Ester No. 18.73

[7] Intengan C. L., and A. P. West. Philip. Journ. Sci. 75 (1941) 83–95.

A portion of the copal (sample 71) was heated at a temperature of 310° to 315° C. for 4.5 hours and converted into run copal and the acid number of the run copal determined. Another portion of sample 71 was run as in the previous experiment, and immediately after running there were added glycerol and zinc dust and the heating continued at 285° to 290° C. for 3 hours. The quantity of glycerol was 10 per cent and the zinc dust 0.5 per cent of the weight of run copal.

The constants for the reaction product 71—B were similar to those obtained for the glycerol-copal reaction product made from sample 47—A.

Analysis of glycerol-copal reaction product.—This substance was separated into its constituents in accordance with the outline in fig. 1.

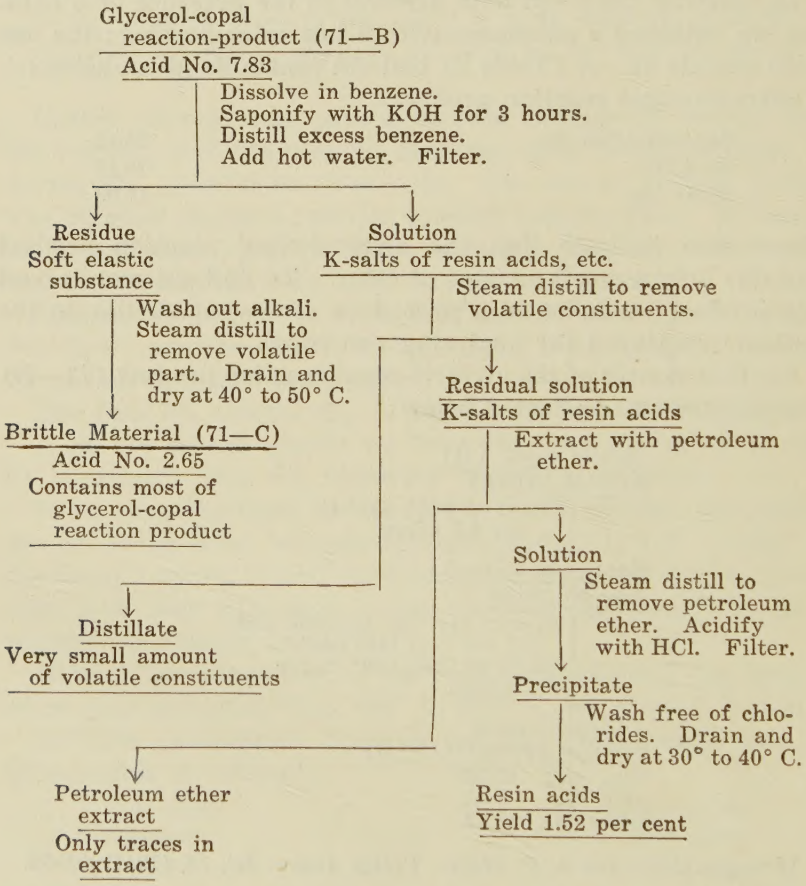

Glycerol-copal reaction-product (71—B)
Acid No. 7.83
Dissolve in benzene.
Saponify with KOH for 3 hours.
Distill excess benzene.
Add hot water. Filter.
Residue
Soft elastic substance
Wash out alkali. Steam distill to remove volatile part. Drain and dry at 40° to 50° C.
Brittle Material (71—C)
Acid No. 2.65
Contains most of glycerol-copal reaction product
Solution
K-salts of resin acids, etc.
Steam distill to remove volatile constituents.
Residual solution
K-salts of resin acids
Extract with petroleum ether.
Solution
Steam distill to remove petroleum ether. Acidify with HCl. Filter.
Precipitate
Wash free of chlorides. Drain and dry at 30° to 40° C.
Resin acids
Yield 1.52 per cent
Distillate
Very small amount of volatile constituents
Petroleum ether extract
Only traces in extract

FIG. 1. Analysis of glycerol-copal reaction product.

Fifty grams of the powdered glycerol-copal reaction product (71—B) were dissolved in benzene, treated with an excess of alcoholic potassium hydroxide, and heated (reflux) for 3 hours. The excess benzene was removed by distilling, and hot water was added to the residue to dissolve the potassium salts of resin acids. A comparatively large amount of a soft, elastic substance with a characteristic odor separated out. This substance was filtered out and washed to remove alkali, and steam distilled to eliminate any volatile constituents and again washed with water. Finally it was drained and dried at 40° to 50° C. During this drying process the soft substance was gradually converted into a brittle material. Most of the glycerol-copal reaction product was converted into this brittle material which was soluble in benzene and benzene-alcohol mixture, slightly soluble in ether, and insoluble in ethyl and methyl alcohols, petroleum ether, and acetone. It gave the following constants:

Constants of the brittle material, 71—C:

Saponification No.	16.91
Acid No.	2.65
Ester No.	14.26

These constants are somewhat similar to those obtained for the brittle, glycerol-copal reaction product, 71—B.

The filtrate from the residue (soft elastic substance) was supposed to contain the potassium salts of resin acids. It was steam distilled to remove volatile constituents. The ether extract of the distillate showed that only traces of such products distilled over. The residual solution was extracted with petroleum ether. Only traces of material were extracted. After extraction the solution was steam distilled to remove petroleum ether, and acidified with hydrochloric acid. The precipitate, consisting of resin acids (text fig. 1), was filtered and washed free of chlorides, drained, and dried at 30° to 40° C. The resin acids were brittle, dark, and transparent, unlike the amorphous resin acids obtained from run copal.

Only a small amount of these resin acids was obtained (yield 1.52 per cent). This result indicated that the brittle glycerol-copal reaction product (71—B) contained very little glycerol-copal ester. It probably consisted mostly of polymerized bodies (resinous esters) somewhat similar to the alkyd resins.[8]

[8] Ellis, C., The Chemistry of Synthetic Resins 2 (1935) 862.

SUMMARY

To make oil varnishes with Manila copal it is customary to heat it until the volatile matter has been removed. This heating process is known in the varnish industry as running.

Although the acidity of Manila copal is considerably reduced by running, the run copal still has a rather high acid number (more than 65 in our experiments).

Due to the acidity of the copal, varnishes made with run copal tend to liver or solidify when mixed with basic pigments, like zinc oxide, to make enamels.

In order to reduce the acidity of run copal this product was heated with glycerol in the presence of zinc dust as catalyst. As a result of this reaction the acid number of the run copal was greatly reduced. Usually the reaction product had an acid number less than 20.

The most suitable conditions for reducing the acidity of run copal were obtained when the amount of glycerol was 10 per cent and the zinc dust was 0.5 per cent of the weight of run copal. For running the copal a temperature of about 315° C. for 3.5 hours, and for the glycerol-copal reaction a temperature of about 260° to 290° C. for 2 hours, were satisfactory. However, since different samples of copal vary considerably in composition the formulation of any general rules is dubious.

The glycerol-copal reaction product was dark brown, very brittle, and transparent. It was soluble in benzene, turpentine, and oils; insoluble in alcohol, ether, chloroform, and alcohol-benzene mixture. When analyzed it was found to consist almost entirely of brittle material which was probably polymerized bodies. It gave low acid and ester numbers and contained only a small amount of copal ester and mere traces of other constituents normally present in run copal.

Oil varnishes were made from run copal and also from the glycerol-copal reaction product, the same formula and procedure being used for both preparations. The glycerol-copal varnish was superior to the varnish made from run copal in that it gave a harder, more brilliant, and elastic film. It was also more resistant to alkalies and could be mixed with basic pigments, like zinc oxide, without livering or solidifying.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Analysis of glycerol-copal reaction product.

CALLUS DEVELOPMENT IN GRAFT UNION[1]

By José B. Juliano[2]
Of the Natural History Museum Division
Department of Agriculture and Commerce, Manila

FOUR PLATES

For a long time much of the importance in the regeneration of callus tissue during graft union has been ascribed solely to the activity of the cambium. In fact, even the most modern of our textbooks(2) has overemphasized the rôle of the cambium in graft union. Recently, Sharples and Gunnery(8) illustrated beyond reasonable doubt that in graft union in *Hevea brasiliensis* and *Hibiscus rosa-sinensis* the formation of a callus tissue between the two symbionts, a very important and necessary adjunct to the actual union of the termini of the two cambia, was not of cambial origin. In the present investigation additional evidence is given to further support the findings of these two authors.

This paper deals primarily with the origin and development of the callus tissue in cleft grafting of *Nothopanax* species. These species are very commonly cultivated around houses as hedge plants, and the ease with which they lend themselves to grafting is not unknown to many of our local horticulturists. Having a rather soft bark and not easily forming a large amount of woody tissue, they prove to be very favorable for such study. Besides, grafts from these plants can easily be obtained in the laboratory by the usual horticultural methods.

MATERIALS AND METHODS

Rooted cuttings of *Nothopanax crispatum* (Bull.) Merr. were obtained from the propagating beds of the Department of Agronomy of the College of Agriculture, University of the Philippines, Agricultural College, Laguna Province, February 10, 1939,

[1] This investigation was done in the College of Agriculture, University of the Philippines, where facilities were at the disposal of the writer.

[2] Formerly Assistant Professor of Agricultural Botany, College of Agriculture, University of the Philippines, Agricultural College, Laguna.

and planted in tin cans filled with fresh garden soil. They were then allowed to grow in the cans until they had reached a height of about two feet. June 4, 1939, the writer requested Mr. Gavino Rotor Jr.,[3] then graduate assistant in the Division of Horticulture, Department of Agronomy, to graft on the growing plants scions of *Nothopanax cochleatum* Merr., locally known as *platitos*. The method employed in effecting the union was the one ordinarily practised in horticulture.

Materials for histological study were collected 15 hours after grafting and every day thereafter for 30 days, and on the 33d, 36th, and 54th day. Slabs from both the stock and scion were fixed and killed in formo-aceto-alcohol (70 per cent), prepared according to the formula given by Chamberlain.(1) They were then dehydrated and cleared with the use of butyl alcohol(9) and embedded in paraffin. Sections of 20 to 25 micra were cut and stained either in safranin-Delafield's hæmatoxylin or safranin with light green or aniline blue.[4]

INVESTIGATION

Microscopical examination of the stems used in this study reveals that they possess a rather thick bark consisting of a single epidermal layer on the periphery, made up of parenchyma (Plate 1, fig. 1; Plate 2, fig. 7) with their outer tangential walls covered by a thick cuticle, the continuity of which is broken by the presence of young lenticels, where a distinct meristem is discernible. Below this epidermis is the cortex. On the outer portion of this cortex is a collenchymatous tissue, consisting of from four to six layers. The rest of the cortex is composed of oblong to rounded parenchyma, smaller at the periphery, becoming larger inward, the outer ones of which may possess chloroplastids (Plate 1, fig. 1). These cortical cells usually possess thick or thin cytoplasm.

The phloem region consists of groups of small, isodiametric cells separated by the broad rays from two to five layers thick. The cambium is only conspicuous where the phloem groups are present, whereas in the rays the cambial cells seem to wane away.

[3] Now graduate assistant in Agricultural Botany.

[4] Credit is due Mr. Potenciano C. Reaño, formerly laboratory helper under the direct supervision of the writer, for cutting and staining the materials used in this study.

The wood portion (Plate 2, fig. 7) is not extensively developed, although secondary thickening has already set in. Traversing the wood are ray cells in rows from one to three cells wide.

The pith occupies the major portion of the stem, and is proportionately larger than the bark and the wood together. It consists of rounded to oblong parenchyma in transverse section, which were smaller around the periphery, becoming larger towards the center. In these cells starch grains are usually found in abundance.

In the preparation of the scion and the stock in grafting, care was taken to make the wounds as smooth as possible. Microscopically, however, the exposed tissue of neither the stock or scion were smooth (Plate 1, fig. 1) when examined 15 hours after grafting. This irregularity may be due either to the dullness of the knife or to the shrinkage of the parenchyma thus killed during the operation, and the slightest shock was perhaps sufficient to kill even some of the cells directly below the cut cells. The latter was more logical cause for this irregularity on the exposed surfaces of both symbionts as utmost care was exercised in the cutting.

The injured cells and some of those lying beneath them lost their moisture and greatly shrunk, even if the wounded areas were covered with budding tape, and their walls became adpressed against the living hypodermal cells. These then formed a dead tissue of some physiological importance to the stem. This death and shrinkage of parenchymatous cells was mostly noticeable in the cortex, phloem, cambial region, and pith (Plate 1, fig. 3) ; that is, wherever parenchyma were present. Cells lying below those that were killed and died remained turgid and retained their original shapes. This phenomenon was more marked in the scion than in the stock.

By the first day after grafting definite activity of the parenchymatous cells near the cut surface was manifest (Plate 1, fig. 5; Plate 3, fig. 13) first in the cortex, and then in the pith (Plate 3, fig. 12). By the 6th day a definite meristematic strip responsible for the regeneration of callus cells had already formed in the bark (Plate 1, figs. 2 and 4). In other words, definite meristematic activity of parenchymatous elements was first exhibited in the bark and then in the pith in both symbionts.

In the bark meristematic activity and consequently the formation of callus tissue was due to the parenchyma below the cut (Plate 1, figs. 2 and 4; Plate 4, figs. 18 and 19). During this ac-

tive callus development in the bark there was no instance where the writer noticed activity of the cambial cells (Plate 1, fig. 4). If there was any, it may be considered negligible (Plate 1, fig. 2). Parenchyma from the cortex as well as the phloem ray cells were a frequent source of callus tissue in the bark.

In the pith callus was mostly derived from its parenchyma (Plate 3, figs. 9 to 11). Callus formation in the pith seemed to be about equal for both symbionts. Where a woody portion of the scion was exposed in grafting, callus tissue formation was relegated to the ray cells (Plate 3, fig. 9) if present at all; otherwise no definite callus was derived from it (Plate 3, figs. 10 and 11). On the other hand, if the woody portion of the stock was exposed, callus was derived mostly from the scion (Plate 3, fig. 9). If pith from both symbionts happened to touch, there was evidently an equal rate of callus development from both, although initiation of callus activity may have begun with the stock. In the pith initial callus development was first confined near the woody portion, and progressively became active inward. As has been stated above, callus formation was much belated in the pith, so that, while the gap existing between the barks of the two symbionts had already been filled up with callus cushions, that in the pith still remained unfilled with callus tissue. Extra callus cells derived from the bark were usually thrown inward to the interior gap, and progressively infiltrated whatever space remained to be filled up in the interior of the graft (Plate 3, figs. 9 and 10; Plate 4, fig. 16).

The last gap to be infiltrated with callus tissue was in the vicinity of the woods of the two symbionts (Plate 4, figs. 18 and 19), and before, but not after the thirteenth day, from grafting the two symbionts became connected throughout with callus cushion (Plate 4, fig. 14). As soon as the callus tissue between the woody portions of the symbionts had been satisfactorily established, some of the callus cells were transformed into conducting elements (Plate 4, fig. 15) with reticulate thickenings, and they may have been rectangular with their long axes parallel to the cut. These would then establish in the callus cushion a new woody portion which would ultimately connect the woods of the two symbionts.

In case the scion happened to be smaller than the stock, so that the bark of both symbionts only coincided at one side, leaving the opposite side to lie enclosed by the stock, the scion exhibited a quite interesting behavior. Initiation of callus was

first noticed around the phloem region, and this activity progressed outward clear to the periphery of the cortex, not excluding the collenchyma layer, and simultaneously a distinct phellogen developed below the epidermis (Plate 3, fig. 8). This combined activity of the meristem in the cortex and that of the phellogen greatly increased the breadth of the bark of the scion in this region of the graft. Concomitant with this activity of the bark of the scion the stock became very active in forming callus tissue which would ultimately enclose the scion (Plate 2, fig. 6).

In longisection of the symbionts callus formation was found to be derived only from the stock if and when the wood of the scion was exposed (Plate 4, fig. 16), and vice versa. The rest of the gap became infiltrated by callus cells derived from the bark. At the region of the split in the stock where the scion was not present (Plate 4, fig. 17), regular wound healing occurred.

Fifty-four days after grafting, when callus tissue had been fully formed between the symbionts, the scion was growing vigorously on the stock and had formed from 4 to 10 new leaves. Internally, however, there was an absence of cambial cells in the callus cushion (Plate 2, fig. 6) which would join the termini of the cambia of the symbionts. It is not within the scope of this paper to further trace the development of callus cells into cambial cells ultimately joining the cambia of the symbionts, but it could be surmised that such development would have taken place if the experiment had been extended further. In this connection Sharples and Gunnery(8) stated that cambial elements in contact with the callus cells on each side of the injury stimulate the adjoining callus cells into active divisions so as to finally form a complete cambial ring. These authors did not, however, try to give definite support to their views, merely stating that new cambial elements did not appear except in close proximity to preexisting cambial elements.

The findings herein presented once more corroborate the findings of Sharples and Gunnery,(8) who stated that the establishment of a cambial bridge across the callused gaps between the symbionts quickly followed the union in *Hevea* and *Hibiscus*. The subject of the origin of callus tissue in grafting operations, either from the cambial elements or from the ray elements, although old, has remained open for discussion up to the present. According to Kostoff,(4) Goppert in 1874 described the joining tissue between the stock and scion as a product of the ray ele-

ments, and pointed out that Sorauer rather questioned this statement. Kostoff himself makes no contribution on this point, and simply states that the joining tissue between the stock and the scion was usually the product of the stock. The present study shows that, even if the initial development of the callus tissue should start with the stock, the contributions of both symbionts were more or less equal. Besides, wherever the ray cells or any parenchyma from either symbionts happened to be near the cut surface in grafting operations these elements always became meristematic and participated in the development of the callus cushion. In the importance of ray elements in wound healing as well as in budding, Rutgers(6) and Jimenez(3) recorded the proliferation of ray cells in branch injuries affected by lightning and in stem cuttings of kapok, achuete, and santol, respectively, while Mann and Gunnery(5) indicated the rôle the ray cells played in bud-grafting in *Hevea brasiliensis*.

According to Eames and MacDaniels,(2)

> Among the functions of the cambium is the formation of callus or wound tissue and the healing of wounds. When wounds occur in roots and stems, masses of soft parenchymatous tissue quickly form on or below the injured surface; this tissue, known as callus, may be formed by the division of parenchymatous cells in the phloem and cortex, but its most frequent source is the cambium.

They further state that

> The important practices of budding and grafting have, as their basis, the *ability of the cambium of both stock and scion* to develop callus and unite, thus forming over the union of stock and scion a continuous cambium layer which will give rise to normal conducting tissue. The whole matter of cambium activity and structure in relation to graft union needs further careful study.

It becomes obvious that this idea should be revised in view of the new findings herein presented, coupled with those of other investigators herein cited.

The question of the activity and proliferation of parenchymatous elements from both the bark and the pith in both symbionts in *Nothopanax* spp., the product of which would pack up the gaps between the two symbionts, has been clearly presented. No evidence of any notable cambial participation in the production of callus tissue was noticed, and it may be supposed that this type of tissue regeneration, as had been already presented for *Hevea brasiliensis* and *Hibiscus rosa-sinensis*(8) and in apple grafts,(7) species of unrelated families, would be found to be a common method in woody stems.

SUMMARY

Clear-cut evidence is herein presented to support the view that before union between a stock and scion in cleft grafting in *Nothopanax* spp. is effected, callus cushions are first formed in the gap through the activity of the parenchyma of both the bark and the pith, and the ray cells of both symbionts. From this callus a cambial bridge is derived in joining the cambial ends of the stock and the scion. The mistake of overemphasizing the rôle played by the cambium in callus formation during graft union is brought out.

Although initiation of callus tissue began with the stock, the contribution of the callus by both symbionts was approximately equal. Callus development was usually initiated first in the bark, where proportionately more callus tissue was formed which greatly infiltrated the gap between the two symbionts.

BIBLIOGRAPHY

1. Chamberlain, C. J. Methods in Plant Histology. Chicago. The University of Chicago Press (1932) 416 pp.
2. Eames, J. A., and H. L. MacDaniels. An Introduction to Plant Anatomy. New York. McGraw Hill Book Company (1925) 364 pp.
3. Jimenez, P. G. Callus and root formations in stem cuttings of kapok, achuete, and santol. Philip. Agriculturist 26 (1937) 585–635.
4. Kostoff, D. Studies on callus tissue. Amer. Journ. Bot. 15 (1928) 565–576.
5. Rubber Research Institute of Malaya. Annual Report, Botanical Division (1928) 39.
6. Rutgers, A. A. L. Bliksemschade bij Hevea. Arch. v. rubbercult. 3d. yr. (1918) 163–171.
7. Sass, J. E. Formation of callus knots on apple grafts as related to the histology of graft union. Bot. Gaz. 94 (1932) 364–380.
8. Sharples, A., and H. Gunnery. Callus formation in Hibiscus rosa-sinensis L. and Hevea brasiliensis Muell. Arg. Ann. Bot. 47 (1933) 827–839.
9. Zirkle, C. The use of n-butyl alcohol in dehydrating woody tissue for paraffin embedding. Science 71 (1930) 103–104.

ILLUSTRATIONS

[All photomicrographs were taken by the photographic studio of the Bureau of Science, Manila.]

PLATE 1

FIG. 1. Portion of a transverse section of the scion (*N. cochleatum* Merr.) 15 hours after grafting, showing unevenness of its exposed surface; *col*, collenchyma; *cp*, cortical parenchyma; *ep*, epidermis. × 64.

2. Portion of a transverse section of the scion (12 days old), showing callus activity mostly derived from the parenchyma of the cortex and very little, if any, from the cambium (*ca*); *cal*, callus tissue; *ph*, phloem; *phr*, phloem ray. × 64.

3. Portion of a transverse section of the stock [*N. crispatum* (Bull.) Merr.], showing shrinkage and death of pith cells 15 hours after grafting. × 64.

4. Portion of the stock, showing callus (*cal*) derived from the bark and its cambium (*ca*) remaining inactive. × 64.

5. Portion of the scion (7 days old), showing development of meristem from the cortical cells; *pf*, phloem fibers. × 578.

PLATE 2

FIG. 6. Transverse section of the symbionts 54 days after grafting; *co*, cortex; *cal*, callus; *l*, lenticel; *inf cal*, infiltrating callus tissue; *pi*, pith; *w*, wood. × 8.

7. Portion of the stock showing its bark and a young lenticel; *ca*, cambium; *cp*, cortical parenchyma; *r*, ray; *ph*, phloem region. × 82.

PLATE 3

8. Portion of a transverse section of the symbionts (scion below), showing activity of the parenchyma near the phloem and cortex, and formation of phellogen (*phe*) below the epidermis; (*ep*) from the scion; *ca*, cambium; *cal*, callus tissue; *col*, collenchyma; *cp*, cortical parenchyma; *ph*, phloem region. × 49.

9. Transverse section of both symbionts, showing activity of the pith cells of the scion (*sc*), of the wood ray cells of the stock (*st*), the infiltrating callus (*inf cal*) cells derived from the bark, and *cal*, callus. × 49.

10. Transverse section of both symbionts, showing activity of the pith cells of the stock (*st pi*), and the infiltrating callus cells (*inf cal*) between; *cal*, callus; *sc pi*, scion pith. × 49.

11. Transverse section of both symbionts, showing activity of the pith cells of the stock (*st*), and the absence of callus formation from the wood of the scion below; *cal*, callus; *sc pi*, pith of the scion. × 49.

FIG. 12. Activity of the pith cells from stock, showing the starch grains. × 226.

13. Initial activity of the parenchyma in the bark of the scion; *cp*, cortical parenchyma; *ph*, phloem region. × 97.

PLATE 4

FIG. 14. Complete infiltration of callus tissue between the symbionts; *cal*, callus; *sc*, scion. × 49.

15. Development of tracheids (*tr*) from among the callus cells between the symbionts; *sc*, scion; *st*, stock. × 49.

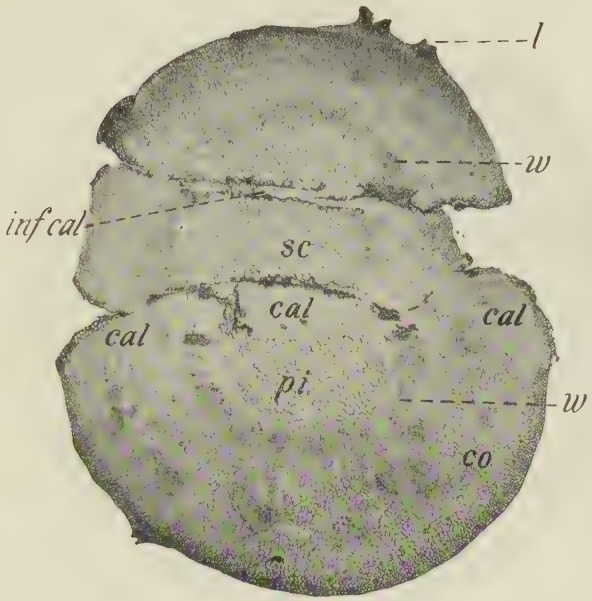
16. Longisection of both symbionts, showing the activity of the pith cells (*st pi*) from the stock and the infiltrating callus cells (*inf cal*) between; scion wood (*sc w*) on the right; *cal*, callus. × 49.

17. Longisection of both symbionts, showing the healing of the wound in the stock (*st*) where the scion (*sc*) is absent. × 49.

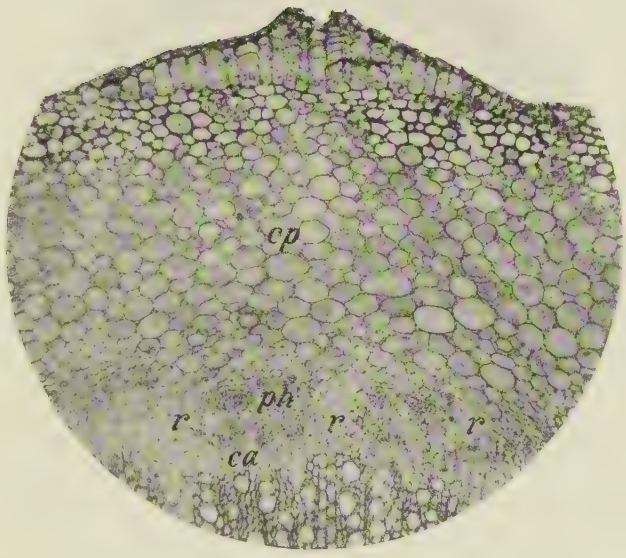
18. Development of callus tissue (*cal*) from the bark of the scion (below) mostly derived from the cortex and the phloem ray cells. Note the absence of callus from the wood (*w*) and the activity of the pith (*pi*) of the stock above. × 49.

19. Transverse section of both symbionts, showing development of callus (*cal*) from the bark and pith of the stock (*st*); *sc*, scion; *w*, wood. × 49.

PLATE 1.

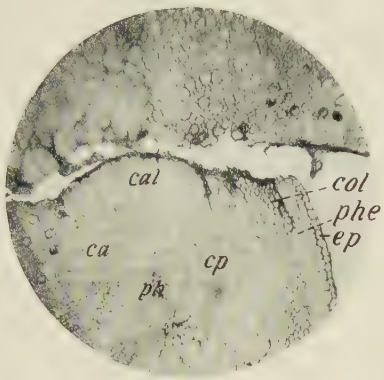


6

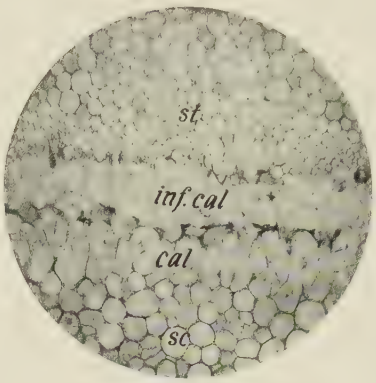


7

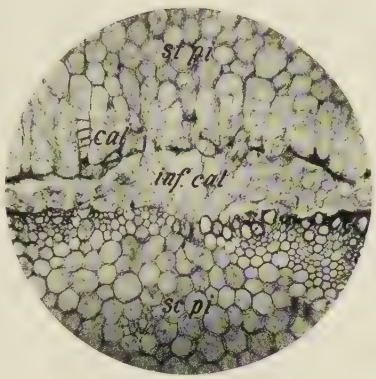
PLATE 2.



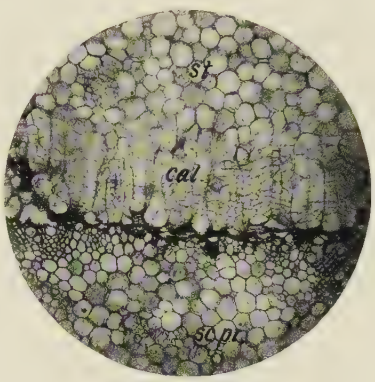
8



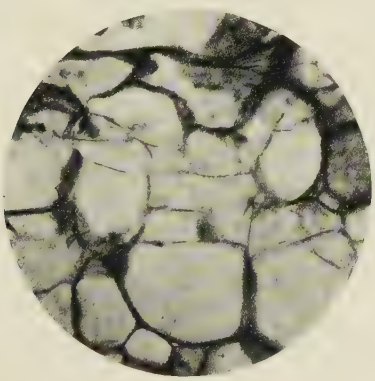
9



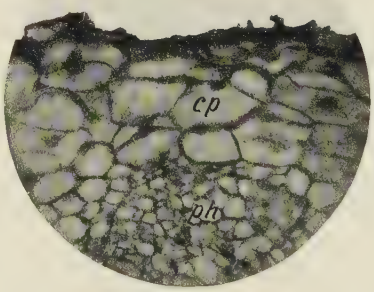
10



11

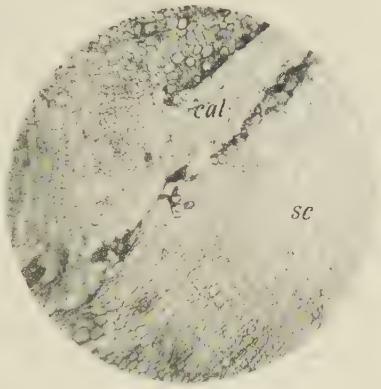


12

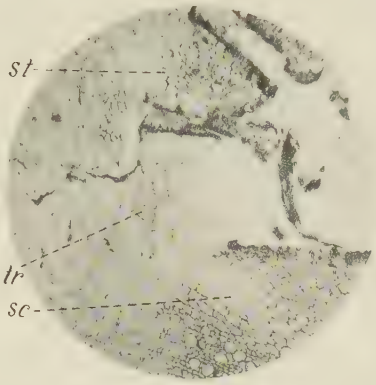


13

PLATE 3.

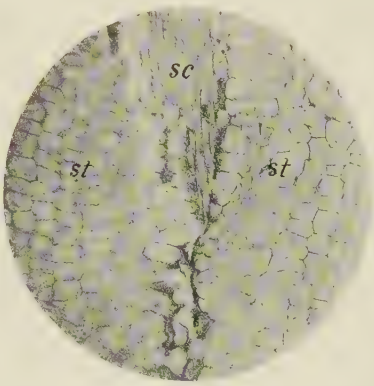


14

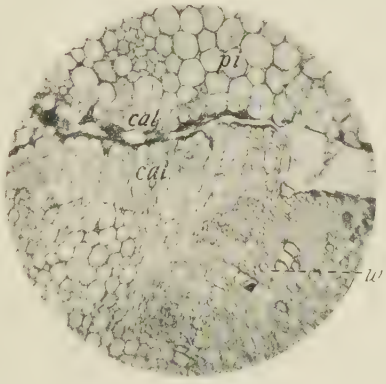


15

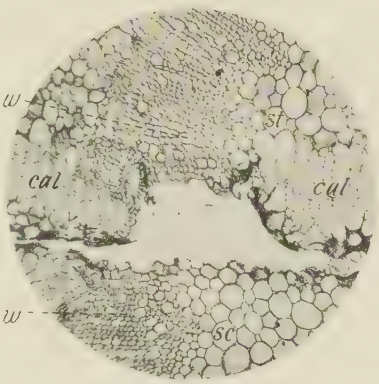
16



17



18



19

PLATE 4.

STUDIES ON THE INFLUENCE OF SPLENECTOMY ON NATURAL AND ACQUIRED IMMUNITY OF RATS TO NIPPOSTRONGYLUS MURIS [1]

By Lope M. Yutuc

Of the College of Veterinary Science
University of the Philippines, Manila

Nine years after Yokogawa(40, 41) described and studied the life history of *Nippostrongylus muris,* Schwartz, Alicata, and Lucker(31) and Africa(1) demonstrated for the first time the resistance of rats to superinfection with this nematode. The former postulated a specific growth-inhibiting substance or substances which delay the development and reduce the egg-laying capacity of the worms, and the latter stated that this condition simulates somewhat the selfcure noted by Stoll(35) in *Hæmonchus contortus* in lambs. The observation on resistance was repeatedly confirmed by more elaborate and extensive investigations of Chandler,(3–10) Spindler,(33, 34) Graham,(15) Porter,(26, 27) Sarles and Taliaferro,(30) and Taliaferro and Sarles.(37) In his first paper Chandler stated that resistance to *Nippostrongylus muris* is not due to a local lethal effect on the nematode in the intestine but to a more general reaction. Because of failure to transfer the immunity passively either by injection or by the use of parabiotic twins, he concluded in his subsequent paper that the immunity is localized in the intestine, claiming that the immune effect is nutritional in nature and possibly due to a development of an antienzyme which affects adversely the activity of the very specialized enzymes by means of which the parasites digest and assimilate the host protein. Later experiments, however, wherein Chandler was able to transfer immunity passively in serum to normal rats, following the work of Sarles and Taliaferro, led him to conclude that general parenteral immunity, like local immunity, is directed primarily against the metabolic products, rather than against the body substance of the worms. In other words, the mechanism of the immunity produced by the worm is closely related to its nutrition.

[1] Thesis submitted to the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore, in partial fulfilment of the requirements for the degree of Master of Science in Hygiene, June, 1939. The writer wishes to acknowledge the helpful guidance of Drs. W. W. Cort and G. F. Otto during the course of the experiments and the writing of the thesis.

Sarles and Taliaferro(30) considered the mechanism of immunity against *Nippostrongylus muris* as "essentially a local immunity in strategically placed organs, i. e. in the skin, lungs, and intestine and to a great extent has an antibody basis." The statement is based on the finding of stunted and immature worms, and precipitates around and in the gut of the worms in the skin and lungs of immune animals. Sarles(29) extended this investigation on the precipitin of immune serum obtained from hyperimmunized rats and found in *in vitro* experiments the formation of precipitates on the cuticle and on the excretory and digestive systems of the larvæ. These precipitates affected the larvæ by decreasing their activity and inhibiting growth. In a recent paper Taliaferro and Sarles(37) reported an extensive study on the cellular reactions of normal and immune rats after infection with *Nippostrongylus muris,* and noted that up to a certain limit the titer of immunity was directly proportional to the number of larvæ and the number of injections of larvæ given to the rats. In initial and light infections, immunity is mainly manifested in the intestine. In moderately infected rats the immune reactions are noted in the lungs as well as in the intestine. Finally, after many heavy infections, it is manifested in the skin also. In their histopathological studies Taliaferro and Sarles observed stunted worms, larvæ immobilized by precipitates, and active cellular response going to the extent of nodule formations with or without living or dead larvæ. In view of these findings they concluded that the immunity developed in *Nippostrongylus muris* infection is primarily humoral with a secondary cellular cooperation.

It is apparent from what has been given here that acquired immunity to *Nippostrongylus muris* is essentially humoral in nature with a secondary cellular cooperation, the nutritional theory and the specific inhibiting substance or substances which have so far not been demonstrated being probably mere after-effects. Further, most investigators tend to assume the point of view that the mechanism of immunity against helminths is similar to, if not identical with, that against other infectious agents.

In the studies on the nature and production of resistance to bacterial and protozoan diseases, the attention of various workers during the past several decades has been directed to the rôle played by the spleen. In discussing the varied functions of this organ, Howell(16) states that the spleen takes an active part in the production of antibodies and immune substances.

Perla and Marmorston(25) consider the spleen an organ of macrophage tissue, and thus explain its importance in the mechanism of resistance. Moreover, in reviewing the literature bearing on the spleen's function in antibody formation, they state that definite evidence of fixation of antigen by the spleen occurs, and that in most cases removal of this organ has resulted in the depression of antibody production. In this connection accumulating evidence indicates that the reticuloendothelial system of which the spleen is a part has an important part in the elaboration of humoral antibodies.(36)

Although enlargement of the spleen had been reported in a few instances, namely, in trichinosis,(22) schistosomiasis,(23) and ancylostomiasis,(12) no attempt has been reported in the literature to determine the influence of the spleen in relation to resistance, natural, acquired, or both, in metazoan parasitic infection.

In view of the foregoing it seems desirable to investigate: (*a*) the effect of splenectomy on natural resistance of rats to *Nippostrongylus muris* infection; (*b*) the influence of splenectomy on the production of acquired resistance to superinfection; and lastly (*c*) whether an acquired immunity already established in the body can be broken down by the removal of the spleen in much the same manner as diet and bleeding have been found to alter it.

MATERIALS AND METHODS

Strain of worms used.—The strain used in these investigations was isolated from the wild dump rats (*Epimys rattus norvegicus*) captured in the Westport Dump, Baltimore. The first strain was lost. The second strain obtained was used in the bulk of the experiments performed. The strain was maintained in the laboratory by passing it through laboratory rats at appropriate intervals.

Strain of rats used.—The rats employed in this investigation were from the inbred laboratory piebald rats of the helminthology colony which were reasonably free from worms and were never infected with *Nippostrongylus muris.*

Care of animals.—In most cases the rats were deloused by liberal use of tincture of larkspur. The experimental animals were kept in small perforated galvanized iron cages which measured 9.5 by 9.25 by 15.5 inches, and were provided with removable pans. All cage pans were cleaned and sterilized once

a week and the entire cage was placed in a steam sterilizer at frequent intervals. To prevent infestation with lice, bedbugs, or other insects, each cage was supported on four wide-mouthed 4-inch bottles standing in a pan of crude oil. The rats were supplied with an abundant diet prepared according to the formula furnished by the biochemistry department. Occasionally the rats were given fresh cabbage leaves. Clean tap water for drinking was always accessible.

Culture and infection method.—Larvæ were procured by culturing in fæces of infected rats mixed with moist bone charcoal. The larvæ appeared at the surface of the culture within five days, and were quite abundant from the 6th to 12th day. In old cultures stunted larvæ were noted. In general 10-day-old cultures were used and isolated by means of the Baermann apparatus. The larvæ used for injection were washed repeatedly in 50-cc centrifuge tubes and the known number estimated by the dilution count in water suspension, as described by Scott.(32) After thorough stirring an appropriate number was drawn off with a 1-cc syringe armed with a 1.5-inch 19-gauge needle, and injected subcutaneously in the region of the back. To avoid leakage, the point of injection was sealed with celloidin.

Splenectomy.—To test the effects of splenectomy on natural and acquired resistance, the spleens of the rats were removed by surgical means. The technique is briefly described as follows: The animal was anæsthetized by intraperitoneal injection of Nembutal (veterinary) in doses of 0.25 cc of a 1 to 9 dilution with sterile water per 50 grams body weight. The hair of the left flank was clipped close to the skin and rendered sterile by a liberal application of tincture of iodine. A bold incision was made on the skin through the tissues as deep as the peritoneum, and the latter opened with scissors. The abdominal incision was dilated with forceps and the spleen lifted up through the wound with fine tissue forceps, ligated, and severed. One or two kalmerid catgut sutures applied to the abdominal wound completed the operation. Rats subjected to the operation were not used for experiment until 6 days after splenectomy.

Out of the 80 splenectomized, 9 rats, 11 per cent, developed rat anæmia. Probably this figure is lower than the actual condition prevailing in the colony. In all these cases *Bartonella muris* was noted on stained blood smears. In young rats 47 days old and less the condition was not noted. This obser-

vation corroborates the finding of Lawkowicz(18) that young rats seem to be free from *Bartonella* infection. However, this finding cannot be taken to mean that young rats are resistant, since Eliot and Ford(13) demonstrated that 3-week-old rats with intact spleen developed anæmia when injected with blood of an anæmic splenectomized rat. Rats found infected with rat anæmia in any set of experiments were discarded with the corresponding number of animals in the control lots, picked at random. Actually 56 rats were employed out of the 80 splenectomized.

Methods of fæcal examination.—To determine the first occurrence of eggs in the fæces after infection or when the modified Stoll counting method failed to reveal eggs in the course of an infection, the Lane direct centrifugal flotation was used. In most of the tests an effort was made to determine quantitatively the number of eggs passed by any animal or group of animals. The Stoll egg-counting technique as modified by Winfield(39) was used for this purpose.

Autopsy methods.—At autopsy the rats were killed with chloroform and the small intestine detached at its union with the stomach and at the junction to the cæcum, removed, and divided into three pieces. These were placed in separate petri dishes, slit open, and worms picked out with fine tissue forceps with the aid of a binocular microscope. At the same time the numbers of male and female worms were determined. The worms collected were preserved and stored in vials.

In some of the experiments the worms in the lungs were roughly estimated by the use of the Baermann apparatus. In experiment 8, after the larvæ were recovered from the lungs by means of the Baermann apparatus, the pieces of lung were examined directly under a binocular microscope for any remaining worms or traces of worms.

EXPERIMENTAL RESULTS

THE EFFECT OF SPLENECTOMY ON THE NATURAL RESISTANCE OF RATS TO NIPPOSTRONGYLID INFECTION

Experiment 1.—Experiment 1 was undertaken to compare the relative egg production and the number of worms in the intestine of nonsplenectomized and splenectomized rats exposed to 420 larvæ administered hypodermically. Table 1 shows that the splenectomized rats had a lower egg count, the maximum being 19,740, observed 10 days after infection. In the non-

splenectomized group the peak of egg production was 31,330 eggs, noted 12 days after infective inoculation. In the actual number of worms collected from the intestine of rats killed 14 days after infection there was an average of 105.5 and 43.5 in nonsplenectomized and splenectomized rats, respectively (Table 2). Twenty-four days after infection an average of 22 worms were recovered from the nonsplenectomized rats and 12.3 worms from the splenectomized animals. There was no difference in the prepatent period in both lots. Twenty-three days after infection the egg count in the nonsplenectomized lot dropped to 1,900 eggs per rat and in the splenectomized group to 430 eggs.

TABLE 1.—*Data from experiment 1, showing the number of eggs from both nonsplenectomized and splenectomized 60-day-old rats, infected with 420 larvæ each.*

Days after infection.	Eggs per day per rat.	
	Non splenectomized.	Splenectomized.
8	[a] +	+
10	27,340	19,740
12	31,330	19,200
14	16,330	15,000
16	20,570	13,170
18	3,410	5,420
21	830	420
23	1,900	430

[a] +, examination by Lane D. C. F. method.

TABLE 2.—*Data from experiment 1, showing the number of worms recovered from both nonsplenectomized and splenectomized 60-day-old rats.*

14 days after infection.					24 days after infection.				
Rat No.	Male worms.	Female worms.	Total worms.	Average.	Rat No.	Male worms.	Female worms.	Total worms.	Average.
NONSPLENECTOMIZED									
1	60	49	109		5	4	7	11	
2	46	56	102	105.5	6	17	9	26	
					7	11	18	29	22.0
SPLENECTOMIZED									
3	13	4	17		8	4	0	4	
4	30	40	70	43.5	9	25	2	27	
					10	3	3	6	12.3

TABLE 3.—*Data from experiment 2, showing the number of worms recovered from nonsplenectomized and splenectomized 73-day-old rats exposed to 410 larvæ. Results of autopsy 12 days after infection.*

Rat No.	Male worms.	Female worms.	Total worms.	Average.
NONSPLENECTOMIZED				
1	46	60	106	
2	33	20	53	
3	13	17	30	
4	5	8	13	50.5
SPLENECTOMIZED				
5	25	28	53	
6	10	11	21	
7	14	8	22	
8	18	28	46	35.5

Experiment 2.—Experiment 2 was merely an extension of experiment 1. The dose of infective inoculation was 410 larvæ per rat. No egg count was made. The results were based on the number of worms recovered from the intestine 12 days after infection. The average number of worms collected from the nonsplenectomized group was 50.5, and the number from the splenectomized group was 35.5, a difference of 15 worms. (Table 3). Another point worthy of consideration was the marked difference of the worm burden, especially in the nonsplenectomized group, as demonstrated in rats 1 and 4, with 106 and 13 worms, respectively.

Experiment 3.—Experiment 3 constituted a further extension of the two previous experiments. However, the procedure was varied to the extent that a pair of rats was killed at a time until all rats used in each lot were exhausted. The infective dose was 600 larvæ per rat. Again there was no difference between the prepatent period of the nonsplenectomized and splenectomized rats. The number of eggs per rat per day was greater in the nonsplenectomized rats, except on the 9th day after infection, when 44,000 eggs were recorded in the nonsplenectomized lot as compared with 62,500 eggs in the splenectomized group. The peak of egg production noted on the 16th and last day was 231,500 for the nonsplenectomized rats and 93,000 for the splenectomized animals. Table 4 gives the data from experiment 3.

TABLE 4.—*Data from experiment 3, showing the egg curve and the number of worms recovered from both nonsplenectomized and splenectomized 37-day-old rats, infected with 600 larvæ from a 10-day-old culture.*

Days after infection.	Eggs per day per rat.	
	Nonsplenectomized.	Splenectomized.
7	[a] +	+
9	44,000	62,500
11		
13	107,660	76,000
15	138,000	89,250
16	231,500	93,000
18		

Days after infection.	Results of autopsy.							
	Nonsplenectomized.				Splenectomized.			
	Male worms.	Female worms.	Total worms.	Average.	Male worms.	Female worms.	Total worms.	Average.
7								
9								
11	83	104	187		107	117	224	
13	92	87	179		75	82	157	
15	127	146	273		135	130	265	
16								
18	151	198	349	247	110	110	220	216.5

[a] +, positive to Lane D. C. F.

Again the splenectomized rats had on the average fewer worms in the intestine. However, in the first pair of rats killed the splenectomized rat had a higher worm burden than the nonsplenectomized animal, the former having 224 worms and the latter 187 worms. In the other three pairs of rats the splenectomized animals had fewer worms than the nonsplenectomized rats.

Experiment 4.—Experiment 4 was an exact duplicate of experiment 3, and the results were essentially similar. The peak of egg output was noted 15 days after infection, 164,400 eggs per rat in the nonsplenectomized lot and 288,750 eggs in the splenectomized group. The smaller number of eggs per day per rat of the nonsplenectomized animals may be attributed to constipation. Table 5 shows that after the peak the nonsplenectomized group carried a higher egg count per day per rat than the splenectomized lot. The last count performed was

on the 21st day after infection, the results being 11,450 eggs for the nonsplenectomized and 150 eggs for the splenectomized rats. As in previous tests, the splenectomized group harbored fewer worms than the nonsplenectomized lot. There was an average of 300.4 worms in the nonsplenectomized lot and 228.8 worms in the splenectomized group, the difference being 71.6 worms. The individual variation in the worm burden of the rats was so marked, however, that no significance can be attached to this difference. Table 5 shows the data for experiment 4.

TABLE 5.—*Data from experiment 4, showing the egg curve and the number of worms recovered from both nonsplenectomized and splenectomized 5-day-old rats, infected with 1,200 larvæ from a 10-day-old culture.*

Days after infection.	Eggs per day per rat.	
	Nonsplenectomized.	Splenectomized.
6	[a] +	+
8	18,500	54,500
15	164,400	288,750
16	90,000	64,300
17	80,700	30,700
18	28,600	6,500
19	34,480	750
20	24,850	560
21	11,450	150

Days after infection.	Results of autopsy.							
	Nonsplenectomized.				Splenectomized.			
	Male worms.	Female worms.	Total worms.	Average.	Male worms.	Female worms.	Total worms.	Average.
6								
8								
15								
16	271	340	611		141	170	311	
17	280	340	620		292	360	652	
18	124	35	159		114	12	126	
19								
20	79	1	80		19	0	19	
21	31	1	32	300.4	36	0	36	228.8

[a] +, positive to Lane D. C. F.

Experiment 5.—While experiments 1 to 4 seem to suggest that the splenectomized rats are slightly more resistant to nippostrongylid infection than the normal animals, the results are far from conclusive. Accordingly any such difference may pos-

sibly be more clearly brought out by the use of lethal doses of larvæ as a means of gauging resistance of the two groups. As shown in Table 6, 38 rats, from 39 to 47 days old, were used. The results show that the minimum lethal dose was 100 larvæ per gram body weight in both groups. With doses of 100 larvæ per gram the total number of larvæ administered to the rats ranged from 4,200 to 7,600, whereas Porter(26, 27) found 15,000 given percutaneously were required to kill even younger animals. This would suggest that a large number of larvæ are lost in percutaneous infection. In the batch of rats given the above dose (rats 10 NS and S, 11 NS and S, 12 NS and S) the splenectomized animals in general lived longer than the nonsplenectomized individuals. In doses greater than 100 larvæ per gram body weight the rats died one to two days after they were given the test infection. All animals subjected to a dose ranging from 100 to 200 larvæ per gram body weight died from hæmorrhagic verminous pneumonia.

TABLE 6.—*Data from experiment 5, showing relative susceptibility of non-splenectomized and splenectomized young rats to various doses of larvæ given per gram live body weight.*

Date of infection.	Rat designation.	Age at time of infection.	Weight of rats.	Infective dose per gram body weight.	Total larvæ given.
		Days.	*g.*		
May 3	8 NS	39	56	50	2,800
Do	8 S	39	56	50	2,800
April 12	9 NS	42	44	100	4,400
Do	9 S	42	42	100	4,200
Do	10 NS	42	56	100	5,600
Do	10 S	42	56	100	5,600
April 13	11 NS	46	88	100	8,800
Do	11 S	46	64	100	6,400
Do	12 NS	46	64	100	6,400
Do	12 S	46	76	100	7,600
Do	13 NS	46	70	150	10,500
Do	13 S	46	72	150	10,800
Do	14 NS	46	88	150	13,200
Do	14 S	46	72	150	13,800
Do	15 NS	46	88	150	13,200
Do	15 S	46	94	150	14,100
Do	16 NS	46	88	150	13,200
Do	16 S	46	90	150	13,500
Do	17 NS	46	124	200	24,800
Do	17 S	46	98	200	19,600
April 14	18 NS	47	82	200	16,400
Do	18 S	47	96	200	19,200
Do	19 NS	47	82	200	16,400
Do	19 S	47	92	200	18,400

TABLE 6.—*Data from experiment 5, showing relative susceptibility of nonsplenectomized and splenectomized young rats to various doses of larvæ given per gram live body weight.*—Continued.

Date of infection.	Results.				Killed or died, after infection.
	Nonsplenectomized.		Splenectomized.		
	Larvæ.	Adults.	Larvæ.	Adults.	
May 3					1 month; no autopsy made.
Do					Do.
April 12	67				3 days; intestine not opened.
Do			116		Do.
Do	370				2 days; intestine not opened.
Do			4	1,648	13 days.
April 13	12	433			10 days.
Do			1	1,222	12 days.
Do	30				6 days; intestine not opened.
Do			30	697	8 days.
Do	184				2 days; intestine not opened.
Do			136		Do.
Do	547				1 day; intestine not opened.
Do			541		Do.
Do	271				2 days; intestine not opened.
Do			418		Do.
Do	317				Do.
Do			606		Do.
Do	363				Do.
Do			1,032		Do.
April 14	160				Do.
Do			1,308		Do.
Do	279				Do.
Do			423		Do.

[a] NS, nonsplenectomized; S, splenectomized. Rat Nos. 1 to 7 were omitted, their results being the same as those of Rat Nos. 8 NS and S.

The larvæ isolated from the lungs of the splenectomized group were generally more numerous than those from the nonsplenectomized lot. Rats 9 NS and S and 15 NS and S to 19 NS and S substantiate the above statement. Exceptions, however, were observed, as in rats 13 NS and S and 14 NS and S.

THE EFFECT OF SPLENECTOMY ON THE PRODUCTION OF RESISTANCE TO SUPERINFECTION

Experiment 6.—Experiment 6 was designed to determine whether the production of acquired resistance may be influenced by the removal of the spleen. For the sake of convenience, at the start of the experiment the rats were divided into groups A and B. The initial immunizing dose was 1,200 larvæ, given subcutaneously. The prepatent period was 6 days after ino-

culation with a 10-day-old culture. The peak of egg production in both lots was 14 days after infection, being 677,200 eggs for the nonsplenectomized lot and 226,000 for the splenectomized group. But the infection died out first in the nonsplenectomized rats. Thirty-eight days after infection no eggs could be recovered by the usual egg-counting method, and on the 45th day the rats were negative by D. C. F. On the contrary, in the splenectomized group the infection persisted, as shown by the egg count performed up to the 45th day. The egg count at this time was 400 eggs per rat. Table 7 gives the data for experiment 6.

TABLE 7.—*Data from experiment 6, egg-curve data from 37-day-old rats exposed to 1,200 larvæ (groups A and B) and reexposed along with group C to 600 larvæ per rat.*

Days after infection.	Eggs per day per rat.		Days after superinfection.	Eggs per day per rat. After 4 days interval.		
	Group A, 5 nonsplenectomized rats.	Group B, 5 splenectomized rats.		Group A, 5 nonsplenectomized rats.	Group B, 5 splenectomized rats.	Group C, 5 nonsplenectomized rats.
6	+	+	6	+	+	+
8	311,200	93,200	7	400	600	2,600
12	268,400	89,200	9	400	600	40,200
14	677,200	226,000	10	400	400	39,400
19	71,200	150,400	12	0	0	88,400
21	193,800	154,400	13	—	+	
23	200	1,400	14	200	0	45,800
38	0	3,800	15	200	200	31,600
45	—	400	16	—	—	30,200

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

After a 4-day-interval these two groups, along with a third lot (designated as group C), which were of the same age but previously worm-free and nonsplenectomized, were each given the test dose of 600 larvæ subcutaneously. Six days later all groups were positive to D. C. F. The course of the infection was again followed by the egg-counting method. There was no appreciable difference between the egg output of the splenectomized and that of the nonsplenectomized rats, the readings being 600 and 400 eggs per rat, respectively. Both groups had apparently developed immunity as a result of the initial infection, since in the control lot a peak of 88,400 eggs

per rat was reached 12 days after the infective dose. The 16th day both splenectomized and nonsplenectomized groups of immunized rats were negative to D. C. F., while the controls gave a reading of 30,200 eggs per animal. The rats in the three groups were killed and the results of the postmortem examination will be described under a separate heading with those of experiments 7 and 8.

Experiment 7.—Experiment 7 was essentially a repetition of experiment 6, and yielded similar results. The peak of egg production was higher in the splenectomized rats than in the nonsplenectomized animals. This condition may be attributed to constipation, as has been observed in experiment 4. At the peak of egg production, 13 days after the immunizing dose, the egg count was 165,640 for the nonsplenectomized lot and 289,870 for the splenectomized group. As time went by the opposite condition operated up to the 30th day after the immunizing injection. Ten days later the nonsplenectomized group was negative while the splenectomized was still positive to the egg-count method, the reading being 170 eggs, quite identical with experiment 6. After a 7-day-interval a test dose of 600 larvæ was administered to each of the rats along with a control (group F). There was an indication of slightly more eggs produced in the splenectomized group than in the nonsplenectomized lot, but it was of too slight significance to merit consideration beyond passing mention. The peak of egg output in the control lot was 172,200 eggs, the 11th day after the test dose. The results of the necropsy will be incorporated with those of experiments 6 and 8. Table 8 gives the data for experiment 7.

THE EFFECT OF SPLENECTOMY ON ACQUIRED RESISTANCE

Experiment 8.—Experiments 8 and 9 were designed to determine the influence of splenectomy on resistance acquired before splenectomy. In this experiment immunization was produced by a subcutaneous injection of 1,200 larvæ per rat. As shown in Table 9, there was no significant difference in the egg count between the two lots of rats (groups G and H) during the course of the initial infection. Six days after the egg count dropped to 100 per rat, 46 days after infection, the rats of group H were splenectomized. Six days thereafter a test infection of 600 larvæ was given to both groups and to an additional lot of normal controls designated as group I. Six days later the controls were positive, while the other two groups

TABLE 8.—*Data from experiment 7, egg-count data from 47-day-old rats exposed to 1,200 larvæ (groups D and E), reexposed along with group F to 600 larvæ per rat 49 days after initial infection.*

Days after infection.	Eggs per day per rat.		Days after superinfection.	Eggs per day per rat. After 7 days interval.		
	Group D, 6 non-splenectomized rats..	Group E, 6 splenectomized rats.		Group D, 6 non-splenectomized rats.	Group E. 6 splenectomized rats.	Group F, 6 non-splenectomized rats.
6	[a] +	+	4	—	—	—
7	20,160	55,410	5	170	0	6,500
13	165,640	289,670	8	0	0	126,670
14	90,000	65,670	9	0	0	172,200
15	81,800	30,000	10	—	—	
16	28,000	6,670	11	100	100	78,830
17	34,850	750	12	0	300	19,300
18	24,850	570	13	100	100	4,500
19	11,860	140	14	—	—	2,300
30	500	330				
40	0	170				

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

were negative to D. C. F. On the 8th day the immunized group gave a reading of 400 eggs, the immunized and splenectomized lot, 600 eggs, and the control group 25,000 eggs per rat. Twelve days after the test infection the immunized and splenectomized group was negative to D. C. F., but the immunized lot continued to maintain an egg count of 400 eggs per rat. The peak of egg output of the control animals (group I) was observed on the 13th day with a recorded count of 80,000 eggs per rat. The last egg count showed the immunized groups negative while the control was still passing 15,800 eggs. The result of the necropsy will be included with those of experiments 6 and 7.

After it was clear that no appreciable rise could be expected in the egg curves of any of the groups used in experiments 6 to 8, all the rats were killed and examined for worms in the intestine and larvæ in the lungs. Groups A, B, and C were killed on the 16th day after the test dose, groups D, E, and F on the 14th, and so on, until all 9 groups had been examined. The resulting data are assembled in Table 10, which shows, in the first place, that postmortem data show extreme variation in the number of worms recovered from the intestine, and in this

TABLE 9.—*Data from experiment 8, egg count from 42-day-old rats exposed to 1,200 larvæ (groups G and H), reexposed along with group I to 600 larvæ per rat 53 days after initial infection.*

Days after infection.	Eggs per day per rat.		Days after superinfection.	Eggs per day per rat. After 12 days interval.		
	Group C, 5 nonsplenectomized rats.	Group H, 5 nonsplenectomized rats.		Group C, 5 nonsplenectomized rats.	Group H, splenectomized 6 days before superinfection.	Group I, 5 nonsplenectomized rats.
6	[a] +	+	5	—	—	—
11	382,400	381,400	6	—	—	+
20	103,000	90,900	8	400	600	25,000
29	1,000	2,770	9	200	0	49,800
35	900	780	10	200	0	37,800
40	100	100	11	0	0	59,800
			12	400	—	55,400
			13	200		80,000
			14	100		19,800
			15	0		15,800

[a] +, positive to Lane D. C. F.; —, negative to Lane D. C. F.

respect support previous observations (Chandler and Graham). The worms obtained from the immunized animals, whether splenectomized or not, fell into three categories, namely adult males, undersized adult males and females, and immature forms, some of the latter being hardly a millimeter long. The adult males only were found in both the immunized groups of experiment 8 (groups G and H). The worm burdens of the control rats (groups C, F, and I) are significantly greater than in the other groups, as shown in Table 10. The difference in the worm burden of groups D and E is largely due to one rat in group D which harbored 31 undersized adults and immature forms. This animal had suffered an accident in which the tail was cut and continued to bleed almost all night long. Moreover, because of the blood thirst initiated by the accident, all the rats in this group were restless and cannibalistically inclined up to the termination of the experiment. In experiment 8 there was a difference in the average of worms recovered from groups G and H, suggesting that the removal of the spleen may have altered the degree of immunity established after an immunizing dose of 1,200 larvæ.

TABLE 10.—*Data on worms found in intestines and lungs of reinfected and control rats at autopsy (experiments 6 to 8).*

[B and E, splenectomized and immunized rats; H, immunized and splenectomized rats; A, D, and G, immunized rats; C, F, and I, controls.]

Experiment.	Group.	Days between infection and autopsy.	Number of worms in intestine. Individual autopsy record.						Average.
6	A	16	1	6	35	18	18	------	15.6
	B	16	11	4	13	14	56	------	19.6
	C	16	77	295	150	50	413	------	197.0
7	D	14	9	9	4	[a]31	3	4	10.0
	E	14	9	2	4	4	1	0	3.3
	F	14	36	3	2	31	57	282	70.0
8	G	15	5	26	34	55	15	------	27.0
	H	15	42	0	33	80	67	------	44.4
	I	15	271	195	107	126	94	------	158.6

Experiment.	Group.	Days between infection and autopsy.	Number of larvæ in lungs. Individual autopsy record.						Average.
6	A	16	3	13	3	2	3	------	4.8
	B	16	3	6	0	5	2	------	3.2
	C	16	0	0	3	0	0	------	0.6
7	D	14	6	11	4	8	13	8	8.3
	E	14	11	13	6	8	11	10	9.8
	F	14	0	4	4	4	3	1	2.6
8	G	15	9	11	16	15	10	------	12.2
	H	15	16	18	19	11	7	------	14.2
	I	15	13	5	6	1	5	------	6.0

[a] Average for group D 5.8 if this animal is omitted (*see* text).

Fewer larvæ were isolated from the lungs of all the control groups than from any of the immunized rats, whether or not the latter had been splenectomized at any time. However, many of the larvæ found in the lungs of the immunized animals either with spleens intact or removed, were in a state of disintegration. More larvæ were obtained from the lungs of the rats employed in experiment 8 than from those in experiments 6 and 7, in which they were recovered by subjecting the lungs for 24 hours to isolation in the Baermann apparatus. In experiment 8 a combined Baermann apparatus and direct binocular examination of the lung tissues thereafter was employed.

Experiment 9.—Experiment 9 was essentially an extension of experiment 8. In determining the degree of resistence already acquired as a result of an immunizing dose of 1,200 larvæ given per rat 52 days previously, lethal doses of larvæ ranging from 21,600 to 33,900 were employed. As shown in Table 11,

all rats in the three groups died. In general the immunized and splenectomized rats lived longer than the immunized animals. The control rats, which were of the same age, succumbed earlier to the lethal doses of larvæ than either the immunized rats or the immunized and subsequently splenectomized animals. If delay in the death of an animal may be considered sufficient indication of the degree of immunity, the results presented suggest to a certain extent that the immunized and splenectomized lot showed slightly more resistance than the immunized rats to lethal doses of larvæ. Further, the immunized rats, whether splenectomized or not, offered slightly more resistance than the normal animals. But in no instance was the immunity acquired sufficiently high to prevent death of the experimental animal.

TABLE 11.—*Data from experiment 9, showing the results obtained by testing the degree of immunity produced by a single injection of 1,200 larvæ per rat March 27, 1939, with a lethal dose of 150 larvæ per gram weight, May 19, 1939.*

Rat No	Weight in grams.	Total larvæ in test dose.	Remarks.
IMMUNIZED AND SPLENECTOMIZED			
1	182	27,300	All died within 8 days after infection; no autopsies made.
2	196	29,400	
3	200	30,000	
IMMUNIZED			
4	202	30,300	All died within 4 days after infection; no autopsies made.
5	202	30,300	
6	226	33,900	
CONTROL			
7	172	25,800	All died within 3 days after infection; no autopsies made.
8	156	23,400	
9	144	21,600	

DISCUSSION

Effect of splenectomy on the natural resistance of rats.—From the results presented in experiments 1 to 4 (Tables 1 to 5) no indication suggestive of a decline in the natural resistance of rats against infection of *Nippostrongylus muris* was observed. If the egg production and the number of worms recovered in postmortem examinations are considered sufficiently significant indications in judging resistance, there seems to be enough evi-

dence to show that resistance against nippostrongylid infection is enhanced instead of depressed as a result of splenectomy, contrary to prevailing observations in bacterial and protozoan infections. To a certain extent this observation may find support in the experiments of Lewis and Margot(19–21) who reported an increased resistance in mice against bovine tuberculosis as a result of splenectomy, attributing it to the production of tuberculosplenatin. Further, Tscherikower and Rubinstein(38) stated that there was no lowering of resistance in guinea pigs to infective jaundice induced by injection with *Spirochæta icterogenes* subsequent to splenectomy. Moreover, in experiment 5 (Table 6) the nonsplenectomized and splenectomized rats were subjected to graded doses of larvæ. Once more, in those that received 100 larvæ per gram body weight the splenectomized animals died later than the nonsplenectomized rats, with the exception of rats 9 NS and S, which died on the same day. The lungs of rats 9 S to 19 S were subjected to the Baermann apparatus and hence more larvæ were recorded from the lungs of splenectomized than from those of nonsplenectomized rats. This condition seems to suggest an activation of the septal tissue of the lungs in the production of macrophages in the splenectomized animals in coöperation with the other cellular elements of the body, bringing about retardation at least in the sojourn of the larvæ in this organ. It is a well-known fact that whenever there is a disturbance in the equilibrium of the body tissues there is a corresponding readjustment, not necessarily structural but possibly functional in nature. In this case the changes would seem to be functional, since structural changes resulting from the loss of the spleen in rats require nearly 2 months (Perla and Marmorston) to develop, and marked changes require 6 months.(24) Taliaferro believes that destruction of the reticuloendothelial system has to be tested within certain time limits, because the system rapidly regenerates due to the proliferation of the cells in other localities. The time limit of 6 days after splenectomy used in various tests here reported is believed to be sufficient margin to preclude the possibility of regeneration and at the same time allow the body to recover from the general depressing effect of the operative trauma and similar factors.

Therefore, if the assumption of the retarding influence of the lungs is correct, the low egg output and the comparatively smaller worm burden in the splenectomized animals as compared with the nonsplenectomized already mentioned, may be attributed to

delay in the evolution of the larvæ from the lungs. This delay would incidentally extend the period of maturity of some of the worms and possibly result in a more prolonged infection. It is not unlikely that this state of affairs is actually initiated to a great extent by the adventitious tissue at the seat of injection and at the onset of infection. The greater span of larval life of *Nippostrongylus muris* is spent in the tissues, namely, the skin and the lungs through which it migrates before it settles down in the intestine as a mature parasite to complete its life attached to the mucosa. In view of this peculiarity the defensive mechanism of the host is more or less concentrated for the most part at strategic points in the body where the parasite actually feeds, grows, migrates, and resides. Its inability to multiply suggests a less exhausting and prolonged struggle against the protective forces of the rat than takes place in bacterial infections. In those experiments where the egg count was followed up to 40 days or more after the initial infection, the nonsplenectomized group lost its infection earlier than the splenectomized lot (Tables 7 and 8). This finding further strengthens the postulate of "delay" in the excursion of the larvæ in the various tissues, especially the lungs, provoked possibly by the removal of the spleen. Therefore, the apparent increased resistance as measured by the egg output, worm burden, and possible delay in the death of some of the experimental animals, may be considered relative in character rather than absolute.

Effect of splenectomy on the production of acquired resistance.—Experiments 6 and 7 (Tables 7 and 8) show that there is no significant difference in the egg production and the number of worms recovered from the splenectomized rats as compared with the nonsplenectomized lot (groups A and B, and D and E in Table 10) after a test dose of 600 larvæ. Although in experiment 7 (Table 10) there are three times as many stunted and immature worms on the average in the splenectomized as in the nonsplenectomized rats, this finding is largely due to one rat in group D which had 31 worms. It will be recalled that this animal accidentally had its tail cut off and bled profusely all night. This finding is in accord with the reports of Cort(11) and Foster,(14) who pointed out that the mechanism of resistance to canine hookworms is sometimes broken by repeated bleeding. In general the results presented may find support in the observation of Benario(2) wherein he failed to note any influence of splenectomy on the capacity of mice to develop an acquired resistance

to certain poisons, as ricin. Kraus and Schiffman(17) observed that splenectomy had little or no effect on the formation of horse serum precipitin or typhoid agglutinins.

As far as the foregoing experiments went, indications are lacking to substantiate the general opinion among some bacteriologists that splenectomy depresses antibody formation as applied to *Nippostrongylus muris* in rats. Some of the reasons presented in the discussion on the effect of splenectomy on natural resistance may account for the unexpected finding.

Effect of splenectomy on acquired resistance.—Having found that the production of antibodies against nippostrongylid infection of rats is not affected by the removal of the spleen, experiments 8 and 9 were undertaken to determine whether immunity once established in the body of the rats can be broken down in much the same manner as with diet and bleeding. The results recorded in experiment 8 (Table 9) demonstrate that splenectomy did not alter the immunity produced in the experimental animals as far as egg output is concerned. On the other hand, if the average worm burden of groups G and H is considered (Table 10), there is indication that the immunity was to some extent altered by the removal of the spleen. In experiment 9, where the death of the experimental animals was used to measure the intensity of the immunity produced, no marked difference was observed between the two groups. In general the immunized rats, either intact or with the spleen ablated, died later than the control group, suggesting that a certain degree of resistance was developed by a single injection of 1,200 larvæ to the point of prolonging life but not to the extent of preventing death. Perla and Marmoston state that the spleen has no influence on the acquired resistance developed by a previous infection from which the animal has completely recovered; for example, the acquired resistance to *Trypanosoma lewisi* in rats is not affected by subsequent ablation of the spleen.

SUMMARY

A series of experiments to determine the influence of splenectomy on the natural and acquired immunity to *Nippostrongylus muris* of rats was performed. The results obtained show that splenectomy did not reduce the natural resistance of rats to nippostrongylid infection. In fact there seems to be some increase in resistance as a result of splenectomy as shown by the lower egg output, the smaller worm burden, and delay in death

of the experimental animals. The production of immune bodies was apparently not influenced by the removal of the spleen, where the operation was done before immunization. Where the splenectomy was performed after immunization there was only a slight reduction, if any at all, in the degree of immunity.

REFERENCES

1. Africa, Candido M. Studies on the host relations of Nippostrongylus muris, with special reference to age resistance and acquired immunity. Journ. Parasit. **18** (1931) 1–13.
2. Benario. Ueber den Einfluss der Milz auf die Immunität. Deutsche med. Wchnschr. **20** (1894) 8, 9.
3. Chandler, Asa C. Experiments on resistance of rats to superinfection with the nematode, Nippostrongylus muris. Amer. Journ. Hyg. **16** (1932) 750–782.
4. Chandler, Asa C. Studies on the nature of immunity to intestinal helminths. I. The local nature of the immunity of white rats to Nippostrongylus infection. Amer. Journ. Hyg. **22** (1935) 157–168.
5. Chandler, Asa C. Studies on the nature of immunity to intestinal infection. II. A study of the correlation between degree of resistance of white rats to Nippostrongylus and interval between infections. Amer. Journ. Hyg. **22** (1935) 243–356.
6. Chandler, Asa C. Studies on the nature of immunity to intestinal helminths. III. Renewal of growth and egg production in Nippostrongylus after transfer from immune to non-immune rats. Amer. Journ. Hyg. **23** (1936) 46–54.
7. Chandler, Asa C. Studies on the nature of immunity to intestinal helminths. IV. The interrelations between parenteral and intestinal immunity in rats infected with Nippostrongylus. Amer. Journ. Hyg. **24** (1936) 129–144.
8. Chandler, Asa C. Studies on the nature of immunity to intestinal helminths. V. Experiments on the role of the skin in parenteral immunity and further experiments on passive immunization in Nippostrongylus infections in rats. Amer. Journ. Hyg. **26** (1937) 292–308.
9. Chandler, Asa C. Studies on the nature of immunity to intestinal helminths. VI. General resume and discussion. Amer. Journ. Hyg. **26** (1937) 309–321.
10. Chandler, Asa C. Further experiments on passive immunity in rats to Nippostrongylus infections. Amer. Journ. Hyg. **28** (1938) 51–62.
11. Cort, W. W. Variations in hookworm disease. Journ. Parasit. **19** (1932) 142–147.
12. Cruz, W. O. Metaplasia mieloide do baco na ancilostomoso. Mem. de Instit. Oswaldo Cruz **28** (1934) 287–298.
13. Eliot, C. P., and W. W. Ford. Further observations on the virus of rat anemia with special reference to its transmission by the rat louse, Polyplax spinulosa. Amer. Journ. Hyg. **10** (1929) 635–642.

14. FOSTER, A. O. On a probable relationship between anemia and susceptibility to hookworm infection. Amer. Journ. Hyg. 24 (1936) 109–128.
15. GRAHAM, G. L. Resistance studies with the nematode, Nippostrongylus muris in laboratory rats. Amer. Journ. Hyg. 20 (1934) 352–372.
16. HOWELL, WILLIAM H. A textbook of physiology. W. B. Saunders Co. (1934) 1132 pp.
17. KRAUS, R., and J. SCHIFFMAN. Precipitines et agglutinines. Ann. Inst. Pasteur 20 (1906) 225–240.
18. LAWKOWICZ, W. Researches on Bartonella muris and its cultivation in vitro. Trans. Royal Soc. Trop. Med. & Hyg. 32 (1939) 601–604.
19. LEWIS, P. A., and A. G. MARGOT. Function of the spleen in experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. 19 (1914) 187–194.
20. LEWIS, P. A., and A. G. MARGOT. Function of the spleen in the experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. 21 (1915) 84–90.
21. LEWIS, P. A., and A. G. MARGOT. The function of the spleen in the experimental infection of albino mice with B. tuberculosis. Journ. Exper. Med. 22 (1915) 359–365.
22. LUBARSCH, O., and F. HONKE. Handbuch der speziellen pathologischen Anatomie und Histologie. I. Berlin, Verlag von Julius Springer (1927) 1161 pp.
23. NISHIKAWA, T. Zur vergleichenden pathologischen Morphologic der verschiedenen chronischen Milztumoren insbesondere bei Schistosomiasis japonica und morbus Banti. Mitt. d. Med. Fak. de Kaiserl. Univ. zu Tokio 21 (1919) 1–25.
24. PERLA, DAVID. Compensatory changes following splenectomy in Bartonella free rats. Proc. Soc. Exp. Biol. and Med. 31 (1934) 983, 984.
25. PERLA, DAVID, and JESSIE MARMORSTON. The spleen and resistance. Baltimore, The Williams and Wilkins Co. (1935) 170 pp.
26. PORTER, DALE A. A comparative study of Nippostrongylus muris in rats and mice. Amer. Journ. Hyg. 22 (1935) 444–466.
27. PORTER, DALE A. Studies on the effect of milk diet on the resistance of rats to Nippostrongylus muris. Amer. Journ. Hyg. 22 (1935) 467–474.
28. PORTER, DALE A. Studies on the pathology of Nippostrongylus muris in rats and mice. Journ. Parasit. 21 (1935) 226–228.
29. SARLES, MERRITT P. The in vitro action of immune rat serum on the nematode, Nippostrongylus muris. Journ. Infec. Dis. 62 (1938) 337–348.
30. SARLES, MERRITT P., and WILLIAM H. TALIAFERRO. The local points of defense and the passive transfer of acquired immunity to Nippostrongylus muris in rats. Journ. Infec. Dis. 59 (1936) 207–220.
31. SCHWARTZ, BENJAMIN, J. E. ALICATA, and J. R. LUCKER. Resistance of rats to superinfections with a nematode, Nippostrongylus muris, and an apparently similar resistance of horses to superinfection with nematodes. Journ. Wash. Academy Sci. 21 (1931) 259–261.

32. Scott, J. Allen. An experimental study of the development of Ancylostoma caninum in normal and abnormal hosts. Amer. Journ. Hyg. 8 (1928) 158–204.
33. Spindler, L. A. Relation of vitamin A to the development of resistance in rats to superinfections with an intestinal nematode, Nippostrongylus muris. Proc. Helm. Soc. Wash. Journ. Parasit. 21 (1933) 72.
34. Spindler, L. A. Resistance of rats to infection with Nippostrongylus muris following administration of the worms by duodénal tube. Amer. Journ. Hyg. 23 (1936) 237–242.
35. Stoll, Norman R. Studies with the strongyloid nematode, Næmonchus contortus. I. Acquired resistance of hosts under natural reinfection conditions out-of-doors. Amer. Journ. Hyg. 10 (1929) 384–418.
36. Taliaferro, William H. The immunology of parasitic infections. New York and London. The Country Co. (1929) 414 pp.
37. Taliafero, William H., and Merritt P. Sarles. The cellular reactions in the skin, lungs, and intestine of normal and immune rats after infection with Nippostrongylus muris. Journ. Infec. Dis. 64 (1939) 157–192.
38. Tscherikower, R. S., and P. L. Rubinstein. Ueber die Bedeutung des retikuloendothelialen Apparates bei Infektionskrankheiten. IV. Das retikuloendotheliale System bei infektiosem Ikterus. Central. f. Bakt. Parasit. und Infek. 114 (1929) 65–68.
39. Winfield, G. F. Quantitative experimental studies on the rat nematode, Heterakis spumosa, Schneider, 1866. Amer. Journ. Hyg. 10 (1933) 168–228.
40. Yokogawa, S. A new nematode from the rat. Journ. Parasit. 7 (1920) 29–33.
41. Yokogawa, S. The development of Heligmosomum muris Yokogawa, a nematode from the intestine of the wild rat. Parasit. 14 (1922) 127–166.

THE ORIGIN OF PLACER GOLD IN SANTA MARIA RIVER, BULACAN

By A. D. Alvir

Of the Natural History Museum Division
Department of Agriculture and Commerce, Manila

ONE PLATE

A few years ago, during the exciting days of the mining boom in the Philippines, the writer staked placer claims covering the Santa Maria River and its tributaries in Bulacan Province. Panning showed 30 to 40 good-sized colors per pan, and an occasional flake of platinum. It was then decided to probe the ground with an empire drill. Forty holes sunk in the vicinity of the Santa Maria Bridge showed that the values were mostly confined to the first one or two feet from the surface. There were only occasional colors below that.

In the course of this exploration the creeks were prospected and followed upstream to their sources. The observations made and data obtained, together with the writer's familiarity with the geology of this area,[1] have supplied the material for this short paper.

On following several of the small branches of the Santa Maria River upcreek, their sources were observed to be in the Alat Conglomerate hills (Plate 1). Since these creeks carried gold, and in larger particles than at Santa Maria Bridge, the immediate source was believed to be the Alat Conglomerate. This theory was borne out by the fact that panning the conglomerate in places which suffered no stream action showed an occasional color. The conglomerate of itself was too poor to hydraulic. The streams rising from these conglomerate hills have acted as sluice boxes, concentrating the gold and platinum along the surface, so that panning the material from them gave a goodly number of colors, the size of which sometimes reached that of a housefly's wing.

This fact has also been established in the small creeks south of Norzagaray, in San Jose del Monte, in Sapang Alat, and in

[1] Alvir, A. D. A Geological Study of the Angat-Novaliches Region. Philippine Journ. Sci. 40 (1929) 359.

Novaliches River. Mariquina River and Angat River carry very little gold because they have ceased to come in contact with the Alat Conglomerate.

The portions of Santa Maria River and its branches east of the Alat Conglomerate carry very little gold, but in the Conglomerate and west of it, the showings are very good. The same can be said of Sapang Alat and Novaliches River.

At Tiakad, near Sapa Biniakdan, north of Mount Tacbuhan, gold can still be panned from the grass roots, near the creek. It will be shown later that the sapa Biniakdan was probably the main Santa Maria River which was flowing westward from the high Sierra Madre Mountains during Pliocene times, that is, during the deposition of the Alat Conglomerate, and was one of the main transportation agents of the gold and platinum now found in the Conglomerate.

CHARACTER OF THE GOLD

The gold found in Santa Maria River and in the other creeks mentioned above occurs as thin flakes, no matter how small the particle. The size varies from a small pinhead to a housefly's wing. The platinum occurs in similar form. In one particle the gold and platinum occurred together, and not merely pounded together, suggesting an ore up in the Sierra Madres in which gold and platinum occur together.

To the flakiness of the gold and platinum is attributed their concentration near the surface. During flood times the river bed is stirred up and the sands settle before do the gold flakes, which swing back and forth in the water, before settling. After the floods many people pan the creeks until the good values along the surface are exhausted.

At Tiakad, mentioned above, the gold is not so flaky, but is a little coarser and more rounded.

ULTIMATE SOURCE OF THE GOLD AND PLATINUM

To understand the ultimate source of the values, it is necessary to consider the geological events which happened during Miocene times and from then up to the present, as well as to have an idea of the Miocene topography and the topographic changes that have taken place up to the present time.

In a previous paper [2] the pre-lava-flow topography of the area east of the Alat Conglomerate in Bulacan Province is dis-

[2] Alvir, A. D. Ibid. pp. 387, 388.

cussed. At that time there were clear-cut, regular, straight ridges trending between north-south and north 15° east. Limestone capped these prominent ridges, and shale and sandstones were probably preserved in the valleys. The streams flowed to the south following the depressions, and undoubtedly there were water gaps across some of the ridges, because the general slope of the area was to the west. The upper course of Angat River is in basement complex rocks which were not covered by the Miocene lava flows, so that its present upper course is the regular development from its pre-lava flow bed. The upper Angat River tributaries follow north and south courses in general. Angat River might have been flowing southward in a north-south depression along the lower course of Ipo River, through the present Mariquina Valley, emptying into a former and greater Manila Bay, and Mariquina River may have been one of its branches.

The Miocene lava flows overran this area and all but drowned it, a few limestone ridges and peaks surviving the flood, being higher than the lava flows. To the west, a limestone ridge hemmed in the lava flow, but to the southwest and south the flow deployed. After the lava flows, therefore, there was a lava plateau which had a natural slope to the west and southwest. We would naturally expect the drainage to flow to the west and southwest from the high Sierra Madre Mountains.

The Pliocene was ushered in by a general submergence in the Philippines, so that the Central Plains of Luzon were occupied by an inland sea. It was during this time that the basal Alat Conglomerates were deposited by the rivers coming from the Sierra Madre and flowing westwardly and southwestwardly over the lava plateau into the inland sea. These rivers, which brought down materials from the Sierra Madre Mountains, also brought down some gold and platinum, especially from the region in and around Angilo Mountains, and Umirey River, which we know is mineralized. This region should also be prospected for platinum.

The gold and platinum grains were incessantly pounded at the beach by the littoral conglomerate motivated by wave action, thus resulting in gold and platinum flakes, instead of rounded grains.

The lower course of Angat River was developed after the lava flow and probably captured its upper courses. Its short tributaries between Ipo and Norzagaray show poor or recent de-

velopment. The peculiarity of the course of Ipo River is very significant. Its upper course flows westward, in line with Sapa Biniakdan, a branch of Santa Maria River. This is clearly a case of stream piracy, whereby a branch of the Angat River, the lower course of Ipo River, cut off the upper course of Ipo River from Sapa Biniakdan. Post-Pliocene faulting and later development and adjustment of drainage has given us the present pattern, one in which the arteries which supplied gold and platinum to the Alat Conglomerate, have been cut off, except the Angat and Mariquina River systems.

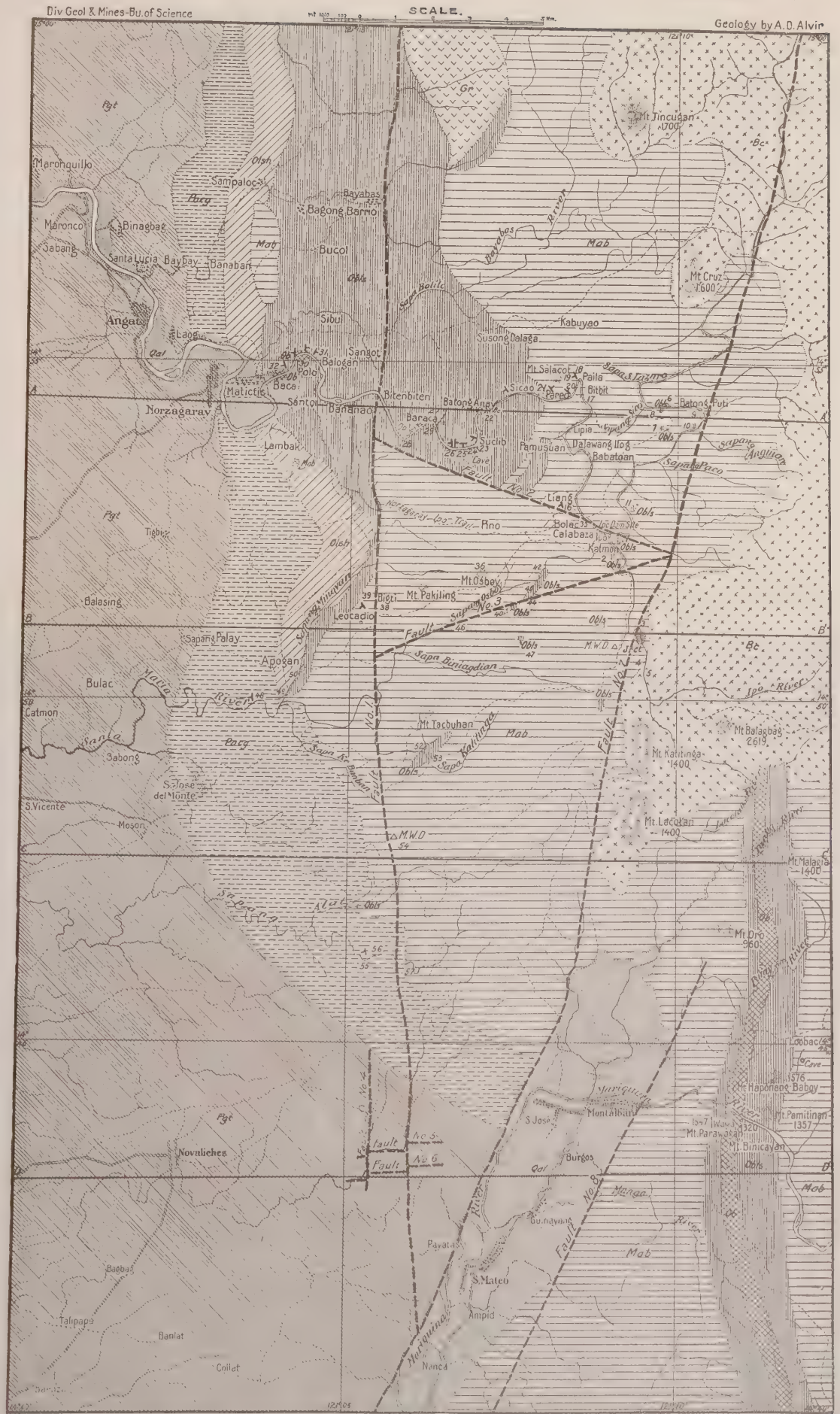
THE CASE OF PAPAYA, NUEVA ECIJA PROVINCE

Samples of placer gold have been submitted to the writer from Papaya, Nueva Ecija Province. The writer has never been to Papaya, but the similarity of the gold flakes, the presence of platinum flakes, and the similarity in topographic position lead him to believe that the origin and history of the Papaya placer deposits are very much the same as those of Santa Maria, Bulacan, and that the basal Pliocene Alat Conglomerates are present in Papaya.

ILLUSTRATION

PLATE 1

Aerial geologic map of the Angat-Novaliches region.



Recent Pleistocene	Pliocene		Miocene	Oligocene			Pre-Tertiary		
Qal	Pgt	Parg	Mab	Olsh	Obls	Ob	Jrct	Be	Gr
Quaternary Alluvium	Guadalupe Tuff	Alat Conglomerate	Lava Flows Basalt & Andesite	Lambak Shales	Binangonan Limestone	Batan Formation Coal Measures	Radiolarian Cherts Jurrassic(?)	Basal Complex Diorites, Gabbros etc.	Granite

PLATE 1.

PRELIMINARY NOTES ON A TREMATODE WITH TWO YOLK RESERVOIRS AND A NEW SPECIES OF LECITHOCHIRIUM

By Sergio P. Acena

Of the University of Washington, Seattle

TWO PLATES

The present study is a continuation of an investigation started by myself on the parasitic fauna of the Puget Sound collections from the Oceanographic Laboratories at Friday Harbor, Washington, during the summer of 1938. One of the hosts, *Sebastodes elongatus* Ayres, was caught in the vicinity of the Laboratory float; the other host, *Sebastodes ruberrimus* Cramer, was taken east of San Juan Island. The trematodes harbored by these fishes were found to belong to rather widely separated families, Opecœlidæ Ozaki (1925) and Hemiuridæ Lühe (1901), respectively. I wish to acknowledge here my obligation to Dr. John Guberlet for his kindly assistance and for the use of his library; and to Miss Edna Lou Grout for assistance on the drawings.

Family OPECOELIDÆ Ozaki

Two mature specimens of this fluke were taken from the mucosa of the rectal portion of the intestine of a rook cod, *Sebastodes elongatus* Ayres, collected below the Cantilever pier at the Oceanographic Laboratories, Friday Harbor, Washington, July 17, 1938. They differ from the already known members of the family Opecœlidæ in having two yolk reservoirs and in the complete inclosure of the seminal vesicle within the cirrus sac. They are therefore placed in a new genus, for which the name *Dideutosaccus* is proposed.

Body small, elongate, flattened, tapering towards anterior end, 3.5 to 4 mm long and 0.45 to 0.5 mm in maximum width across anterior testis. Cutile fairly thick, smooth, and thrown into folds in contracted specimens. Preacetabular region 0.4 to 0.45 mm. Postacetabular region 2 to 2.5 mm. Posttesticular region 0.62 mm. Suckers small; ventral sucker twice as large as oral. Oral sucker subterminal, 0.15 by 0.14 mm. Ventral suc-

ker sessile, almost ovate, 0.36 by 0.27 mm. Prepharynx absent; pharynx somewhat fusiform, muscular, 0.015 by 0.007 mm. Œsophagus short, 0.006 by 0.002 mm. Intestinal crura simple, without lateral branches, uniting at posterior end to open on ventral surface near posterior extremity.

Excretory pore terminal. Excretory vesicle tubular, running forward through testicular region to about posterior margin of anterior testis. Two fine branches arising from the rather enlarged anterior end.

Testes almost ovate, one behind the other on the median line; posterior testes larger than anterior organ. Anterior testis 0.19 by 0.27 mm. Posterior testis 0.28 by 0.26 mm. Seminal receptacle anterodorsal to ovary, short-ovate, cirrus small, muscular and pyriform, 0.06 by 0.04 mm, inclosing elongate, tortuous seminal vesicle and pars prostatica. External seminal vesicle absent. Genital pore sinistral, at level of pharyngoœsophageal junction.

Ovary ovate, median, overlapping anteroventral surface of anterior testis, 0.11 by 0.24 mm. Two oblong yolk reservoirs present, one on each side of anterior border of ovary. Cotype and Mehlis glands anterior to ovary, between yolk reservoirs. Uterine coils intercæcal, between shell gland and acetabulum. Metraterm short and muscular. Laurer's canal present. Eggs 0.07 by 0.03 mm. Vitelline follicles extending from behind posterior margin of acetabulum to posterior extremity of the body and uniting behind testis.

Host.—*Sebastodes elongatus* Ayres.

Location.—Rectum.

Locality.—Friday Harbor, Washington.

Type species.—Acena Helminthological collection No. 34.

Genus DIDEUTOSACCUS novum

Opecœlidæ: Body elongate, tapering towards anterior end. Cuticle smooth. Acetabulum sessile, larger than oral sucker, at posterior portion of first fourth of body length. Œsophagus very short. Genital pore sinistral, at level of pharyngoœsophageal junction. Cirrus sac small, pyriform, inclosing long tortuous seminal vesicle and prostate. External seminal vesicle absent. Testes tandem, postovarial, postequatorial. Ovary ovate, immediately anterior to testes. Seminal receptacle anterodorsal to ovary. Vitellaria in small follicles, extending from behind ventral sucker to posterior end of body. Two yolk reservoirs present, anterodorsal to ovary, united mesially by a

common duct. Eggs fairly large, not numerous. Intestinal parasites of marine fish.

Type species.—Dideutosaccus radifistuli sp. nov.

HEMIURIDÆ

LECITHOCHIRIUM MEDIUS sp. nov. Plate 2.

Six worms of this species were found in the stomach of a red snapper, *Sebastodes ruberrimus* Cramer, taken at Friday Harbor, Washington, from about 70 feet of water east of San Juan Island.

Lühe (1901) established the genus *Lecithochirium* with *Lecithochirium rufovirida* (Rudophi) as the type species. A distinct feature separating *Lecithochirium* from the very similar genus, *Sterrhurus* Looss (1907), is the presence of a presomatic pit with an underlying cell pad. The genus also includes *L. gravidum* Looss, *L. excisum* Rudolphi, *L. excisiforme* Cohn, *L. synodi* Manter, *L. psenopsis* Yamaguti, *L. magnacetabulum* Yamaguti, *L. pagrosomi* Yamaguti, *L. japonicum* Yamaguti, and *L. exodicum* MacFarlane.

Body with tail appendage either wholly or partly retracted, 2.5 to 3 by 0.65 to 0.74 mm, widest at level of posterior half of acetabulum. Cuticula smooth. Appendage with rings. Preacetabular region 0.65 mm. Posttesticular region, 0.45 mm. Ventral sucker sessile, equatorial, about two and one half times size of oral sucker. Oral sucker without internal elevations. Preacetabular pit median, with pads of cells underlying it. Pharynx present, elliptical. Œsophagus very short. Intestinal cæca simple, not extending into tail appendage. Excretory pore terminal in tail appendage. Excretory vesicle V-shaped. Genital pore sinistral, at level of pharyngoœsophageal junction. Testes, ovary, and vitellaria characteristic of the genus. Seminal vesicle greatly convoluted, leading directly into the pyriform pars prostatica. Seminal vesicle reaching posteriorly to about midportion of ventral sucker. Cirrus sac small, muscular, pyriform. Ovary elliptical, 0.22 by 0.12 mm, behind and in contact with posterior testis. Vitellaria compact; lobes rounded. Yolk reservoir present, small, ovate, 0.08 by 0.01 mm, posterodorsal to ovary and between vitellaria. Uterus never entering tail appendage. Metraterm muscular, long. Laurer's canal present. Eggs numerous, small, 0.03 by 0.01 mm.

Host.—Sebastodes ruberrimus Cramer.

Location.—Stomach.

Locality.—East of San Juan Island, Washington.

Type species.—Acena Helminthological collection No. 23.

L. medius differs from *L. synodi* Manter (1931) and from *L. microstomum* Chandler (1935) in the relative ratio of the suckers and in the forms of the seminal vesicle and the pars prostatica, and from *L. exodicum* MacFarlane (1936) in the size of the eggs.

REFERENCES

ACENA, SERGIO P. A new genus and three new species of Digenetic Trematodes from Puget Sound Fishes. M. S. Thesis (1940) 1–70, 7 pls. 12 figs.

CHANDLER, ASA C. Parasites of fishes in Galveston Bay. Proc. U. S. Nat. Mus. (2977) 83 (1935) 127, 128, 1 pl., 2 figs.

LLOYD, L. C. Some digenetic trematodes from Puget Sound fishes. Journ. Parasit. (2) 24 (1938) 103–133, 4 pls., 35 figs.

LOOSS, A. Beiträge zur Systematic der Distomen. Zool. Jahrb. Syst. 26 (1907) 64–80.

MACFARLANE, S. H. A study of trematodes from marine fishes of Departure Bay, B. C. Journ. Biol. Board Canada 2 (1936) 335–347.

MANTER, H. W. Some marine fish trematodes of Maine. Journ. Parasit. 12 (1925) 11–18.

MANTER, H. W. Some digenetic trematodes from deep water fish of Tortugas, Florida. Carnegie Inst. Wash. Publ. No. 435, Papers Tortugas Labontoy 28 (1934) 261–345.

ILLUSTRATIONS

[Legends: *an*, anus; *eg*, egg; *exp*, excretory pore; *exv*, excretory vesicle; *gp*, genital pore; *int*, intestine; *lc*, Laurer's canal; *m*, metraterm; *œ*, œsophagus; *oomg*, ootype and Mehlis glands; *os*, oral sucker; *ov*, ovary; *pap*, preacetabular pit; *par*, parenchyma; *ph*, pharynx; *pr*, pars prostatica; *sr*, seminal receptacle; *ss*, sinus sac; *sv*, seminal vesicle; *t*, testes; *ut*, uterus; *vs*, ventral sucker; *vit*, vitelline glands; *yg*, yolk glands; *yr*, yolk reservoir.]

Plate 1

Fig. 1. *Dideutosaccus radifistuli* gen. et sp. nov.; whole mount, ventral view.

2. Semidiagrammatic reconstruction of genital complex of *Dideutosaccus radifistuli* sp. nov.

3. *Dideutosaccus radifistuli* sp. nov. Reconstruction of the terminal genital ducts.

Plate 2

4. Egg of *Lecithochirium medius* sp. nov.

5. *Lecithochirium medius* sp. nov.; whole mount, ventral view.

6. *Lecithochirium medius* sp. nov., reconstruction of terminal genital tract.

7. *Lecithochirium medius* sp. nov., reconstruction of genital complex.

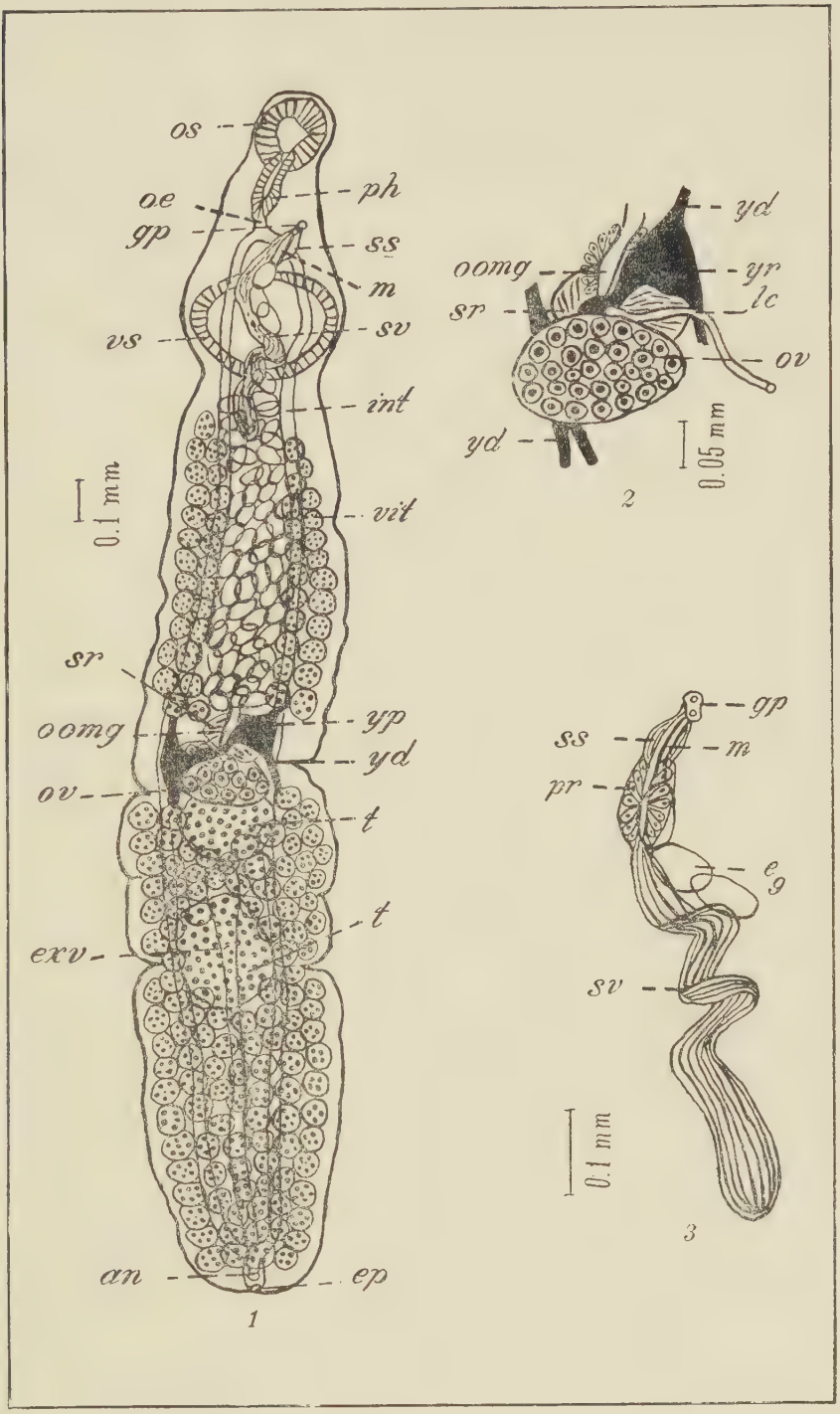

os
oe
ph
gp
ss
m
vs
sv
int
0.1 mm
vit
sr
oomg
yp
yd
ov
t
t
exv
an
ep
1
yd
oomg
yr
sr
lc
ov
yd
0.05 mm
2
gp
ss
m
pr
eg
sv
0.1 mm
3

PLATE 1.

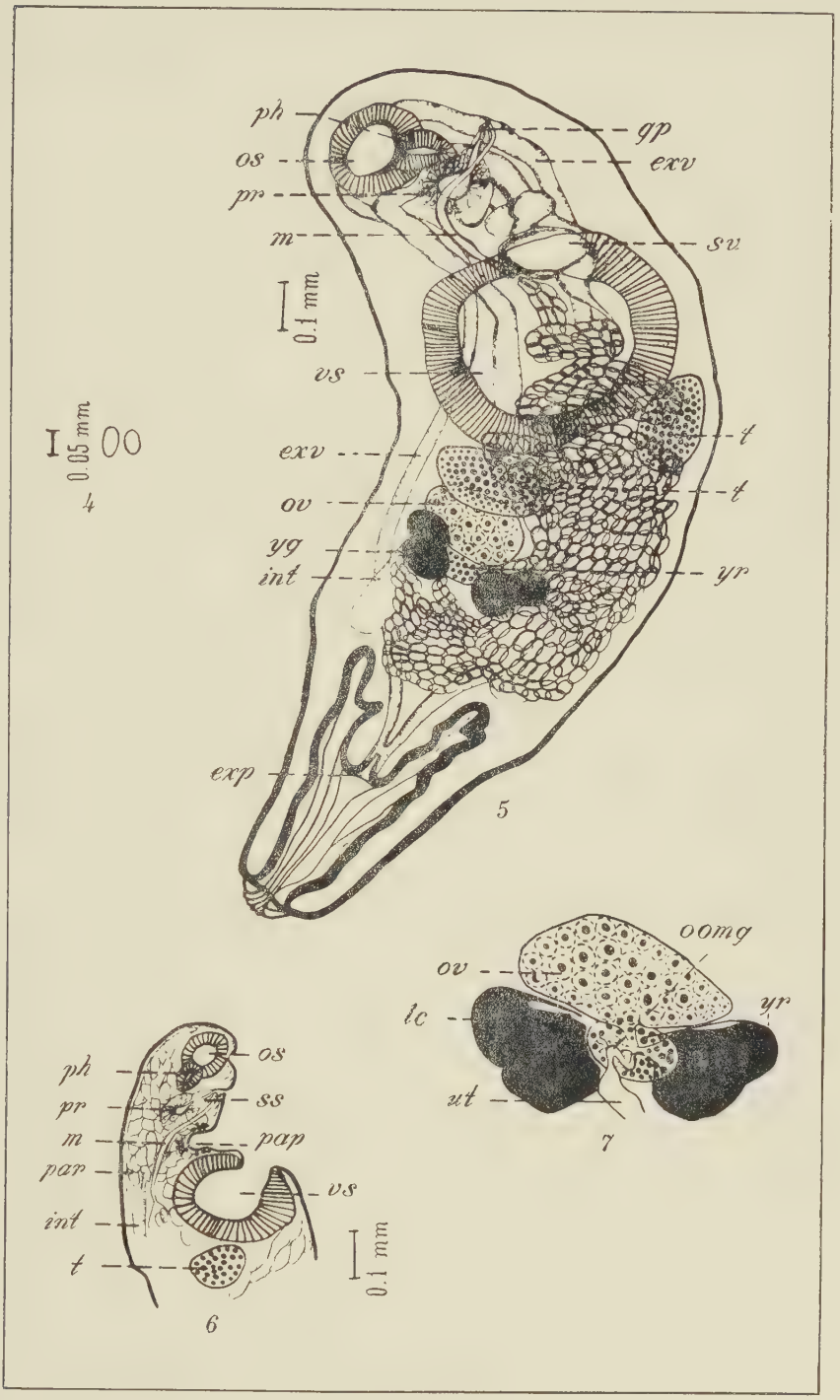

ph
os
pr
m
0.1 mm
vs
exv
ov
yg
int
exp
gp
exv
sv
t
t
yr
0.05 mm
4
5
oomg
ov
lc
ut
yr
7
ph
pr
m
par
int
t
os
ss
pap
vs
0.1 mm
6

PLATE 2.

TYPES OF WATERCRAFT IN THE PHILIPPINES

By Ricardo E. Galang

Of the Natural History Museum Division
Department of Agriculture and Commerce, Manila

THIRTEEN PLATES

The geographical structure of the Philippines, with its innumerable navigable rivers, bays, gulfs, and seas; the difficulties of land transportation in the rural districts during seasons of heavy rainfall; the temporary character of the roadbeds and the makeshift bridges which are often carried away by the swollen streams; the lack of sufficient funds for repairs and for new construction of roads—all these conditions favor the use of diverse types of watercraft in the Philippine Archipelago. Most of the watercraft are considered native, but there are not a few foreign types which have proved useful in the Islands' domestic as well as foreign trade. Of the latter types the steamships and the sailboats stand first in importance.

The boats used by the ancient Filipinos were extraordinarily large and carried 100 rowers and about 30 or 60 fighting men. These were of East Indian and Oceanic origin. The large boats were built of planks, while the smaller craft were simply hewn-out logs and, when new, absolutely leak-proof. All but the smallest canoes were provided with outriggers—stout bamboos or light logs extending parallel with the hull but held at some distance from it by a bamboo frame. The outriggers prevented the boat from capsizing. Wooden pegs and rattan lashings held the parts together. On the larger vessels, generally used for fighting, a platform raised above the middle length of the hull supported the fighters, and an awning of mats protected them from the heat of the sun and, to a slight extent, shielded them from view and thus from the arrows and spears of their enemies. The mast, which in former times probably consisted of matting of buri or pandan leaves, could be lowered or raised with the sail. Wide paddles, instead of rudders, were used for steering. The craft was very shallow, so that even the larger boats could be drawn up on shore at night. With such vessels the

Moros long practiced piracy and contested control of the southern seas and islands with the Spaniards.

It is the prime object of this paper to give a description of the different types of watercraft in use in the islands since the time of their discovery. The list, arranged in alphabetical order to give facility for reference to those who are interested in their study, includes a few obsolete types which have ceased to be useful as means of water transportation.

Almadia (*almadie*).[1]—A small native fishing boat mentioned by Antonio Pigafetta in his *Primo Viaggio Intorno Al Mundo* between 1519 and 1522. The name is derived from the Spanish word *almadia*, a sort of canoe used by the inhabitants of the East Indies. It also refers to a boat used by the Portuguese and their slaves in the East Indies. Used in crossing rivers.

Balandra (*sloop*).[2]—A coasting or light sailing vessel with one mast. Mentioned by Jesuit Father Juan de Zarzuela June 19, 1691, in Extracts from Jesuit Letters.

Balsa (*raft*).—A floating platform, usually composed of wooden logs, planks, or bamboos, or the like, fastened together by nails, spikes, cordage, or rattan, and used for the carriage of goods and passengers. Logs and bamboos transported to the market are often made into rafts to facilitate their transportation. In all probability the balsa was the first man-made device for travel on water. Balsas have been in use by all peoples since prehistoric times. Common at present in Abra, Batangas, Isabela, and other provinces. (Plate 1, figs. 1 and 2.)

Banca (*vanca*).[3]—A kind of Philippine canoe, made from a hollowed tree trunk, like the American dugout. Sometimes provided with outriggers to prevent it from capsizing. Often roofed with thinly split bamboos and trestlework of buri or nipa leaves, called *carang* in Pampangan. In use up to the present, principally in navigable rivers, lakes, and creeks, and to some extent in bays or gulfs, for fishing or for the transportation of goods from one place to another. Common in Pampanga, Bulacan and other Provinces, and in Manila. (Plate 2, figs. 1 and 2.)

Bancon.[4]—A boat with three oars on each side of the hull. Of Chinese origin. Said to be used by the Chinese in minor depre-

[1] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898 33 (1906) 213, 315.

[2] Op. cit. 41 (1906) 35.

[3] Op. cit. 4 (1903) 184.

[4] Op. cit. 25 (1905) 118.

dations along the coasts of the Philippines. Appeared in the islands sometime in 1635–1636, when the Portuguese were trading at Manila.

Barangay (*balanghai, balanguai, barangaye*).[5]—The most primitive and the most characteristic boat in the Philippines. Described by historical writers as "a sharp slender craft, pointed at both ends, and put together with wooden nails and pegs." Propelled by oars and sails. The name of this boat was later taken to mean a group or social organization composed of a family or a group of families known as *barangayes;* thus was preserved the remembrance of the conveyance by which their forefathers reached the Islands. As the various families came hither, each in its own barangay—all during the voyage under the command of a *cabeza* (a head captain or pilot)—the land was partitioned among them, subject to their respective cabezas (later known as *datus* or *maguinoos*) who directed them on the sea. The barangay was used between 1576 and 1582, during the expedition to Borneo, Jolo, and Mindanao. Particularly common in Cagayan and Isabela. (Plate 4, fig. 1.)

Barca chata.[6]—A flat-bottomed boat capable of carrying heavy loads. Generally used for artillery. Mentioned by Antonio de Morga in his Sucesos in 1609.

Barcoluengo.[7]—An oblong boat with a round bow, its only mast being in the center. Usually provided with sailors, soldiers, ammunition, and provisions necessary for at least a year's voyage, and a cosmographer, skillful in geometrical tables, for accurate recording on map or chart of new discoveries. Used in establishing a way station for Philippine vessels on the California coast, in 1605–1609.

Bark (*barca*).[8]—Formerly a small sailing vessel, as a pinnace or fishing smack. Also a rowboat, or a three-masted vessel, having foremast and mainmast square-rigged, and mizzenmast fore-and-aft rigged. Mentioned in The Agustinians in the Philippines, 1670–1694.

Baroto (*baloto, boloto*).[9]—A sort of dugout used mainly as a lighter, for unloading larger vessels. Sometimes more than 80 feet long. This type of vessel was used by Governor Francisco de Sande in his expedition to Borneo, Jolo, and Mindanao in 1576–1582. Common in Capiz, Cebu, Surigao, Ilocos Sur, and Tayabas Provinces.

[5] Op. cit. 4 (1903) 184.
[6] Op. cit. 16 (1904) 50.
[7] Op. cit. 14 (1904) 183.
[8] Op. cit. 42 (1906) 118.
[9] Op. cit. 4 (1903) 197.

Batel.[10]—A type of vessel provided with sails, oars, and a rudder. Used in navigable rivers and quiet seas. Generally loaded with goods and merchandise. This type of vessel is commonly used in Batangas and Tayabas Provinces.

Bigniday (*biguiday, biniray*).[11]—A vessel resembling a prao, a large banca, or the *binitan.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo (1519–1522).

Bileg.[12]—A native boat in Ilocos Norte Province, used at sea. It is similar to the *virey.*

Bilis (*bilus*).[13]—A baloto (canoe dug out of a single log), 20 varias [14] long. Its hull alone is called *dalámas.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo (1519–1522).

Binitan.[15]—Formerly made by the people of Catanduanes. For more detailed description *see viroco.*

Brigantine.[16]—A piratical vessel or any light swift vessel used in the Mediterranean and the Levant. Also a two-masted, square-rigged vessel, differing from a brig in that she does not carry a square mainsail. Mentioned in the Expedition of Miguel Lopez de Legaspi (1521–1569).

Canoa (*canoe*).[17]—A dugout scooped out of a single tree trunk and holding one or two persons. Mentioned in De Moluccis Insulis (1493–1529). Common in most islands.

Cañonero (*gunboat*).[18]—A light steam vessel with a steel hull and of 20 to 30 horse power, constructed in England for the Spaniards for use against the Moro pirates. Very effective in reducing Moro piracy in Lake Lanao district, Mindanao, and in adjacent islands in 1670–1700. Mentioned in Jolo and the Sulus from Charles Wilke's Narrative of the United States Exploring Expedition.

[10] Op. cit. 19 (1904) 60.

[11] Op. cit. 33 (1906) 239.

[12] Census of the Philippine Islands: 1903. 4 (1905) 589.

[13] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 30 (1906) 343.

[14] One vara equals 0.85 meter.

[15] Op. cit. 16 (1904) 107.

[16] Webster New International Dictionary of the English Language (1938) 336.

[17] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 1 (1903) 322.

[18] Op. cit. 43 (1906) 185.

Caracoa (*carcoa*).[19]—A large canoe used by the Malays. Provided with two rows of oars, very light, and fitted with a European sail, its rigging of native manufacture. Mentioned in the Negotiations between Legaspi and Gonzalo Pereira, Commander-in-chief, regarding the Spanish settlement at Cebu sometime in 1568–1569.

Carangail.[20]—A vessel of the Moro pirates which attacked the Spaniards at Jolo, and plundered the Pintados (Bisayans) at Oton, Cebu. Mentioned in Pintados Menaced by Mindanao Pirates (1599–1602).

Caravel (*carabela*).[21]—A small vessel of the 15th and 16th centuries with broad bow, high, narrow poop, three or four masts, and usually lateen sails on the two or three aftermasts. Columbus had two caravels with him on his great voyage. The name also refers to a Portuguese vessel of 100 or 150 tons. Mentioned in the Treaty of Tordesillas in 1493–1529.

Casco.[22]—A long almost rectangular barge or lighter, sometimes with sails. Principally used for loading merchandise. Very common in the islands. (Plate 4, fig. 2.)

Chalana (*scow*).[23]—A large flat-bottomed boat, having broad, square ends, chiefly used as a lighter or for transporting refuse to its place of disposal. Found mostly in Manila, Cavite, and Olongapo. (Plate 5, fig. 2.)

Chalupa (*shallop*).[24]—A light, open boat used chiefly on rivers. Propelled by oars or sails or by both. Usually provided with two masts carrying fore-and-aft sails or lugsails. It appeared in the Philippines in 1521–1569.

Champan (*sampan*).[25]—A Chinese vessel described by Retana as being "about as large as a Spanish *patache,* but inferior to the junks of the Chinese. It is used by the Chinese for trading in the Filipinas Islands." The term is now applied to a boat 12 or 15 feet long in which a family often makes its home on the

[19] Op. cit. 2 (1903) 246.

[20] Op. cit. 11 (1904) 297.

[21] Op. cit. 1 (1903) 124–126.

[22] Webster New International Dictionary of the English Language (1938) 414.

[23] Op. cit. p. 445.

[24] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 11 (1904) 158.

[25] Op. cit. 5 (1903) 194.

Canton River. Mentioned in Juan Bautista Roman's letter to the Viceroy in 1582–1583. (Plate 6, fig. 1.)

Cho.[26]—A kind of craft used in Philippine waters, the sails of which are made of rushes. It is a weak vessel, plying in China Sea, usually loaded with slaves, pepper, and various kinds of cotton cloth. Used in 1627.

Cris-craft (*speedboat*).—A very fast boat made of planks propelled by a motor of great power. It is used only in sports and for pleasure trips; because of the high cost of construction and maintenance only the rich can afford to buy it.

Cutter.—A broad square-sterned boat for carrying stores and passengers, either rowed, sailed, or propelled by engines. Also a vessel with one mast, rigged in most essentials like a sloop, although usually with a reefing bowsprit and topmast. It is narrower and deeper than a typical sloop. At present the commonwealth government is using cutters for official trips.

Dapang.—A swift light vessel of the Samal Moros similar to the vinta which sails in and out of the hundreds of reefs and islands composing the Sulu Group.

Falua (*faluca, felucca*).[27]—A small, open boat, or a long boat with oars. Also a narrow, fast, lateen-rigged vessel, commonly three-masted, chiefly used in the Mediterranean. It is usually low with an awning in place of an upper deck, and with provision for the use of oars when necessary. Mentioned by Father Francisco Mastrili in the Conquest of Mindanao in 1636–1637. (Plate 7, fig. 1.)

Ferryboat (*passage boat*).—A vessel for conveying passengers, merchandise, and other cargo across a river or other narrow bodies of water. Also a boat which carries passengers from Manila to the port of Cavite (Plate 6, fig. 2).

Filipote (*flyboat*).[28]—Formerly a large flat-bottom coasting vessel or a round sailing vessel. Now a kind of fast passenger or freight boat used on canals in England. Mentioned in Formosa Lost to Spain 1640–1649.

Fisolere (*fucelere, fusiniere*).[29]—A small and very swift oared vessel, used in winter on the Venetian lakes by the Venetian nobles for hunting with bows and arrows and guns. Mentioned by Antonio Pigafetta in his Primo Viaggio Intoro Al Mundo 1519–1522.

[26] Op. cit. 22 (1904) 186.
[27] Op. cit. 27 (1905) 256.
[28] Op. cit. 35 (1906) 135.
[29] Op. cit. 33 (1906) 232.

Fragata (*frigate*).[30]—A light vessel propelled by sails and oars. Supplied with men and provisions. Mentioned in the Account of Expedition to Borneo and Jolo, Mindanao (1576–1582).

Funea.[31]—From the Japanese *funé* which means 'boat.' This may be etymologically equivalent to the English word 'funny' a small, clinker-built, narrow rowboat. Mentioned in Morga's Sucesos de las Islas Filipinas in 1609.

Fusta.[32]—A small vessel with lateen sails. During the expedition of Ruy Lopez de Villalobos in 1521 this type of vessel was equipped with ammunitions, artillery, weapons, and provisions.

Gabarra (*barge*).[33]—A roomy boat, usually flat-bottomed, used principally in harbors and on rivers and canals for the conveyance of passengers or goods. The name also refers to a pleasure boat elegantly furnished. Mentioned in Relation to Events in the Filipinas Islands 1629–1630.

Galizabra.[34]—A vessel with lateen-rigged sails, used in the Levant trade. Its name is of Arabic origin. Mentioned in Military affairs of the Islands (1597–1599).

Galleon.[35]—A huge, round-stemmed, clumsy vessel with bulwarks 3 to 4 feet thick and built up at stem and stern like castles. Also a sailing vessel of the 15th and following centuries. Often having 3 or 4 decks, and used for war or for commerce by the Spaniards as treasure ships in their American trade (particularly between Mexico and Manila). Usually of from 1,200 to 1,500 tons burden, and carrying 50 to 60 guns. The latter, however, for lack of space, were generally banished to the hold during the eastward voyage. Homeward, with plenty of space to spare, the guns were remounted. The galleons by instruction wore the royal flag, although some were put under foreign colors. The officers were commissioned and uniformed like the officers of the Spanish navy, and the ships were under the same regulation and discipline. Mentioned in the Historical Introduction of the Philippine Islands by Edward Gaylord Bourne 1493–1529 (Plate 7, fig. 2).

[30] Op. cit. 4 (1903) 156.
[31] Op. cit. 15 (1904) 118.
[32] Op. cit. 2 (1903) 60.
[33] Op. cit. 23 (1904) 89.
[34] Op. cit. 10 (1904) 213.
[35] Craig, Austin. The former Philippines through foreign eyes (1931) 64.

Galley (*galera*).[36]—A large, low, usually one-decked vessel, propelled by both oars and sails, used through the Middle Ages, especially in the Mediterranean, for war, trading, ceremonial, and pleasure purposes. The typical war galley of the Mediterranean was from 100 to 200 feet long, often having 20 oars on each side with two or three rowers to each oar. It had 2 or 3 masts rigged with lateen sails, carried guns at prow and stern and a complement of as many as 1,000 to 1,200 men. Very efficient in Mediæval warfare. This type of vessel was mentioned in the Expedition of Villalobos in 1521–1569.

Garay.[37]—An ancient sailboat or a long canoelike boat with two outriggers and with 40 or 60 oars. Used by the Moro pirates from Sulu, particularly the notorious Balangingi Samals. Equipped with lantacas, spears, krises, and barongs. An expedition is officered by the following: (*a*) the *nakura*, who is the commander: (*b*) the *julmuri*, who acts as first mate, in charge of the crew (*sakay*), watches the boat for leakage, and controls the rudder (*bausan*); (*c*) the *julbato*, who is in charge of the anchor (*sao*), guards the prow, and keeps a lookout for reefs, rocks, and enemy ships. The booty generally consists of slaves, jewelry, and silver and gold coins. Slaves and goods were allotted in kind, or sold and the proceeds divided along with the money booty. Division was made among the officers and crew according to rank and work after the shares of the sultan and the *panglima* or datu has been set aside. (Plate 8, fig. 1.)

Goleta (*schooner*).[38]—A fore-and-aft rigged vessel having two masts, with the smaller sail on the foremast, and mainmast stepped nearly amidship. Mentioned in Remarks on the Philippine Islands, and on their Capital Manila, 1819–1822. (Plate 8, fig. 2.)

Guilálas.—A vessel made of planks used in navigable rivers for loading merchandise. Similar to the casco or the barangay. Formerly common in some parts of the islands.

Houseboat.[39]—A covered boat used as a dwelling. Carved from a single log 40 to 50 feet long and 6 feet or more in diam-

[36] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 2 (1903) 49.

[37] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 64.

[38] Funk & Wagnall's New Standard Dictionary of the English Language (1929) 1052.

[39] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 17 (1904) 264.

eter. Usually a large flat-bottomed boat with a superstructure much like a house. Used for cruising along quiet waters on sea or rivers. Mentioned in Portuguese and Spanish Expedition Against the Dutch, 1615. Common also in southern waters. (Plate 9, fig. 1.)

Jañgua.[40]—A small, armed vessel like a raft. Mentioned in the Conquest of the Molucas Islands by Bartolome Leonardo Argensola in 1609.

Joañga (*juañga*).[41]—A flatboat. According to Retana and Pastells the name is derived from the Chinese word *chun,* which means 'boat'. Regarded as a small junk. Mentioned in Morga's Sucesos, 1609.

Junk (*junco*).[42]—A characteristic Chinese vessel having as common features, bluff lines, very high poop and overhanging stem, little or no keel, and polemasts, usually very high, carrying lugsails or round sails woven out of palm fibers with battens running entirely across. The leech of the lug is often much curved and the rudder usually drops below the keel. Impelled by the wind only when it blows directly fore-and-aft. Mentioned in De Moluccis Insulis. Common in the islands in 1493–1529. (Plate 9, fig. 2.)

Kurikanan.—A small, swift, and very light fishing boat, usually paddled by one or two men. Furnished with outriggers and sail. Common in Batangas and Mindoro.

Lampitaw.[43]—A small boat still in use in the Philippines. According to Rizal, the word *lopis,* another type of boat, is a transformation of the Tagal word *lampitaw.* Mentioned in Morga's Sucesos de las Islas Filipinas in 1609.

Lancan.[44]—A type of boat usel by the ancient Christian Filipinos in Mindanao. Similar to the *prao* or *parao* and used in rivers and bays. Mentioned in a letter written by Father Pablo Pastells to the Father Provincial, Juan Capell., S. J., in 1887.

Lancha (*launch*).[45]—A small vessel navigated with sails and oars; or an open undecked boat of any size driven by steam or other power, used as a pleasure craft or for carrying passengers short distances. Common in Manila, Sorsogon, and Samar. Used in establishing a way station for Philippine vessels on the California Coast in 1605–1609.

[40] Op. cit. 14 (1904) 238.
[41] Tom. cit. 54.
[42] Op. cit. 1 (1903) 305.
[43] Op. cit. 15 (1904) 90.
[44] Op. cit. 43 (1906) 273.
[45] Op. cit. 14 (1904) 183.

Lapis.[46]—A roomy vessel used to carry merchandise. For a more detailed description *see tapaque.*

Lipa.[47]—A passenger boat of the Mohammedan Moros, made at the Tawitawi Islands. It is usually longer and slower than the other Moro boats and constructed without outriggers. It is built up from canoes by the addition of planks upon the sides.

Longboat.[48]—A large boat carried by a merchant sailing vessel, corresponding to the sailing launch of a naval vessel. Mentioned in the Affairs in Filipinas in 1644–1647.

Lorcha.[49]—A Chinese vessel, lighter and swifter than the junk, using oars and sails. Mentioned in Morga's Sucesos de las Islas Filipinas in 1609. Common in Capiz, Cebu, Sorsogon, and Leyte.

Lunday (*lunde*).—A banca or dugout without outriggers. Used in fishing and for passenger transportation without cargo. Very common in the islands.

Mangcuerna.[50]—A vessel used chiefly in transporting merchandise in La Union Province. Used on quiet seas and navigable rivers. Propelled by oars only.

Mosca.[51]—A French vessel which had been captured by the parish priest of Batangas, Fray Melchor Fernandez, together with the dispatches carried on that vessel. Mentioned in Representation in the Spanish Cortes, 1801–1840.

Pailebote.—A boat in which pilots cruise offshore to meet incoming vessels. It is usually a strong, fast, weatherly boat, now sometimes using steam. Common in ports of call.

Panco (*prao*).[52]—A vessel of the Moro pirates with extraordinary swiftness. Made of planks lashed together with rattans, without sail or any other ligature. Its masts consisted of three bamboos, its rigging of a few pieces of rattan or the bark of trees, its sails of *petates* or mats, called *saguran.* Some of those vessels used in piratical expeditions were large and fitted out with 50, 100, or sometimes 200 men. The shots of their scanty and defective artillery were very uncertain, because they gener-

[46] Op. cit. 9 (1904) 296.

[47] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 16.

[48] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 35 (1906) 262.

[49] Op. cit. 14 (1904) 57.

[50] Census of the Philippine Islands: 1903 (1905) 282.

[51] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 51 (1907) 282.

[52] Op. cit. 43 (1906) 273.

ally carried their guns suspended on slings. These men, however, were dexterous in the management of the campilans. Mentioned in the Reforms in Filipinas 1801–1840.

Pangue.[53]—A native boat particularly used in rivers. Mentioned in the Ecclesiastical Survey of the Philippine Islands in 1637–1638.

Parcado.—A large Philippine outrigger with two masts for sails. Roofed with trestle work of bamboo and buri or nipa leaves. Common in Tayabas, Mindoro, and Batangas. (Plate 10, fig. 1.)

Pilan.[54]—A small boat used in 1638–1640, equipped for the transportation of fighting men and ammunition. In 1609–1700 the pilans were the vessels that captured the *joanga*, a flat boat, manned by Moros from Mintun (*Mutul*) which carried Father Lopez to Simuay, Cotabato. Mentioned in Events in Filipinas.

Pinaza (*pinnace*).[55]—A light sailing vessel, often schooner-rigged, sometimes also using oars, used largely as a tender for warship or other large vessels. Mentioned in a letter of Francisco de Ortega to the Viceroy in 1580–1605.

Piragua (*pirogue*).[56]—A very swift and light dugout canoe used by the natives in Mindanao. Mentioned in Events in Filipinas in 1721–1739.

Pitsuya.—A large vessel made of planks provided with narrow bamboo rafts with oars and *tiquines* (long bamboo poles) on each side. Used in navigable rivers for loading merchandise.

Pontin.[57]—A stoutly built coasting vessel of European model, from 80 to 150 tons, with two long mat sails, like a Chinese junk. Used in coastwise trade in 1801–1840. Mentioned in a letter from Father Quirico More to the Father Superior of the Mission, 1885. Common in La Union Province.

Prao (*parao, prahu, proe, prow—Malay*).[58]—A large, swift, flat boat with two masts and lateen sails. Used for carrying freight and employed in the rivers and bays. It resembled the *fusta.* Its sails are made of palm mats. It is of from 20 to 30 tons burden, and propelled by both sails and oars. Draws but little water and is a fast sailer, well suited to navigation through dangerous seas. The vessels are armed with muskets, blunderbusses, krises, hatchets, and spears, and at times two large

[53] Op. cit. 28 (1905) 212.
[54] Op. cit. 29 (1905) 144.
[55] Op. cit. 34 (1906) 271.
[56] Op. cit. 29 (1905) 171.
[57] Op. cit. 43 (1906) 194.
[58] Op. cit. 2 (1903) 144.

mounted guns. Mentioned in Resumé of Contemporaneous Documents, 1559–1568.

Salisipan.—A very light and fast craft used by the Moros on their piratical expedition. Common in southern waters.

Sapit.[59]—A large cargo boat of the Mohammedan Moros made by the Samal people of the Tawitawi Islands. Built up from a keel, the cutting and shaping done by hand. Typically Moro. (Plate 11, fig. 2.)

Saraboa (*salambao*).[60]—A fishing raft of reeds or bamboo on which is erected an apparatus not unlike the mast and yard of a square-rigged ship. The nets used in the bay or river are suspended by the four corners from hoops attached to a crane by which they are lowered into the water. This type of fishing raft is used in the islands up to the present time (Plate 11, fig. 1).

Sloop.[61]—A vessel having one mast and fore-and-aft rig, consisting of a boom-and-gaff mainsail, a jib or jibs, often a stay sail, and usually a gaff topsail. The typical sloop has a fixed bowsprit, topmast, and standing rigging; those of the cutter type may be readily shifted. This type of vessel appeared in the Philippines in 1880.

Soma.[62]—A large vessel from Great China laden with merchandise. These boats came in groups to Manila with the monsoon and settled weather which generally came with the advent of the New Moon in March. Mentioned in Morga's Sucesos. 1609.

Steamboat (*steamship*).[63]—A vessel propelled by steam power generally used in navigable rivers and seas as coasting craft. Used at present in the islands for transporting merchandise and passengers. (Plate 10, fig. 2.)

Taculi.[64]—A type of transportation vessel used in Cagayan River for loading merchandise. Propelled by oars. Similar to the virey or barangay.

Talisay.[65]—A fisherman's boat made of talisay (*Terminalia catappa*). Mentioned in Events in Manila in 1662–1663.

[59] Orosa, Sixto Y. The Sulu Archipelago and its people (1931) 16.

[60] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 53 (1906) 149.

[61] Op. cit. 39 (1906) 31.

[62] Op. cit. 14 (1904) 177.

[63] Webster New International Dictionary of the English Language (1938) 2465.

[64] Census of the Philippine Islands: 1903 (1905) 588.

[65] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 34 (1906) 223.

Tapaque.[66]—A large, light, roomy vessel for conveyance of merchandise. Can be dragged on shore at night; navigated without going into the open sea or leaving the shore. Some of these tapaques were so long that they could carry 100 rowers on one side and 30 soldiers above to fight. Mentioned by Antonio de Morga in his Sucesos de las Islas Filipinas in 1609.

Taratana.[67]—One of the armed vessels sent against the Moro pirates during 1721–1734 under the command of Antonio Roxas who sailed from Manila on July 10, 1721, to attack Jolo.

Tataya.—A carvel-built vessel provided with three oars on each side of the hull. Each oar is tied with rope to a wooden peg. It is held together by rattan lashing. No iron nail is used. Usually painted with charcoal and lime. Used on sea. Common in Batanes Islands at present.

Tugboat (*towboat*).—A strongly built, powerful steam vessel, whose engineer, bunkers, and stokehole occupy practically all the room except that needed for the crew. Common in ports of call like Manila, Iloilo, Cebu, and Tacloban.

Tunguli (*timghuly*).[68]—A small boat usually with the squadrons of *praos.* Mentioned by Antonio Pigafetta in his Primo Viaggio Intorno Al Mundo in 1519–1522.

Urca.[69]—Built like a pink—that is, with a very narrow stern—and sloop-rigged. Mounted with 24 pieces of artillery. Mentioned in a letter of Juan de Silva to Philip III in 1609–1616.

Vilox.[70]—A boat made of wood and bamboo. A common means of transportation in Iloilo for loading merchandise on sea and river.

Vinta.[71]—A general utility boat of the Moros which is built in the rough at Basilan Island and brought south for the ornamental carving of its bows and sides. Equipped with bamboo outriggers and propelled by paddles or by a lateen sail of muslin attached to a tripod mast of bamboo which is stepped well forward. It is usually so light that a foot and a half of water depth suffices. It can easily go up the streams and brooks. It is still in use at present. Common in Mindanao and Sulu. (Plate 12, fig. 2.)

[66] Op. cit. 14 (1904) 83.
[67] Op. cit. 46 (1906) 223.
[68] Op. cit. 33 (1906) 221.
[69] Op. cit. 17 (1904) 145.
[70] Census of the Philippine Islands: 1903 (1905) 589.
[71] Blair, Helen Emma, and James Alexander Robertson. The Philippine Islands 1493–1898. 41 (1906) 305.

Virey (*birey, viray*).[28]—An unsteady vessel navigated only near the shore. Mentioned in Sande's Relation in 1576. Common in Cagayan, Ilocos Norte, Ilocos Sur, and La Union Provinces.

Vinorco (*birroco*).[29]—A light vessel made in Catanduanes and sold in a curious manner. A large vessel, undecked, without iron nail or any fastening is first built. Another vessel is made to fit its hull. Within that they put a second, a third, and so on. Thus, a large birroco often contains 10 or 12 vessels, called *birroco, virey, barangay,* and *bintas*. Mentioned in Morga's Sucesos de las Islas Filipinas (1609).

Yacht.—A vessel larger than a rowboat, used either for private trips, or as a vessel of state to convey distinguished persons from one place to another on official trips. The name also refers to swift small racing sailboats.

Zalon (*zalon*).[30]—A Spanish flagship used in expedition to Sulu in 1638–1640. On her return voyage it collided with a champan from Manila which carried Father Marcelo Mastril. The shock was so severe that the flagship sprung a leak and went down. One Spaniard and one Sangley were drowned. Mentioned in Events in Filipinas (1721–1739).

Zebeck (*zebec*).[31]—A Mediterranean vessel with long overhanging bow and stern, usually three-masted, lateen-rigged, but often carrying square sails on the foremast. Formerly used as corsairs. Mentioned in Vice Admiral S Cornish's letter to Mr. Cleveland in 1759–1765.

[28] Op. cit. 4 (1903) 26.
[29] Op. cit. 14 (1904) 107.
[30] Op. cit. 29 (1904) 23.
[31] Op. cit. 49 (1907) 44.

ILLUSTRATIONS

PLATE 1

FIG. 1. The *balsa* (raft) a makeshift means of conveyance across rivers.
2. The *balsa* full of passengers and vehicles crossing Laoag River.

PLATE 2

FIG. 1. Typical dug-out boat known as *banca, canoe,* or *lunday.*
2. Bancas roofed with trestlework of bamboo and buri or nipa leaves.

PLATE 3

FIG. 1. A Philippine canoe with outriggers.
2. An outrigger canoe with sail.

PLATE 4

FIG. 1. The *barangay,* the most primitive and the most characteristic boat in the islands.
2. A fleet of casco on the Pasig River for loading merchandise.

PLATE 5

FIG. 1. Another type of casco with masts for sails. (After Palgrave.)
2. *Chalana* (scow) full of passengers and motor vehicles.

PLATE 6

FIG. 1. *Champan,* a Chinese vessel used by the Chinese for trading in the Philippines. (After Webster.)
2. An ancient type of passage boat (ferry boat) for conveying passengers across a river. (After La Gironiere.)

PLATE 7

FIG. 1. *Falua,* a fast, three-masted, lateen-rigged vessel found in the islands some time in 1636–1637. (After Webster.)
2. Galleon, a 15th century sailing vessel used for war or for commerce by the Spaniards in the Manila-Acapulco Trade. (After Webster.)

PLATE 8

FIG. 1. *Garays* of the Sulu Moro pirates that spread terror on the seas. (After Orosa.)
2. *Goleta* moored at Iloilo River. (After Laureano.)

PLATE 9

FIG. 1. A Bajao houseboat in the Sulu Sea. (After Orosa.)
2. Junk, a characteristic Chinese vessel formerly found in the islands. (After Webster.)

PLATE 10

FIG. 1. *Parcado*, a large Philippine outrigger with masts and sails.
2. Inter-island vessel used at present in navigable rivers and seas as coasting craft.

PLATE 11

FIG. 1. *Saraboa* (salambao), or fishing raft. (After La Gironiere.)
2. *Sapit*, a large cargo boat of the Samal Moros. (After Taylor.)

PLATE 12

FIG. 1. Canadian Pacific Liner (Empress of Asia), at Pier 7.
2. *Vinta*, a general utility boat of the Samal Moros. (After Taylor.)

PLATE 13

FIG. 1. Ship building at Dagupan, Pangasinan Province.
2. A fleet of Moro Vintas with buntings on festive occasion.

1

2

PLATE 1.

1

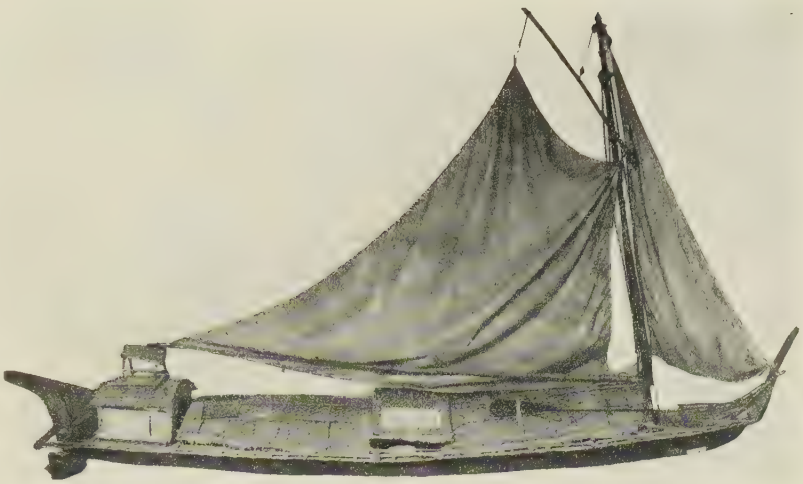
2

PLATE 2.

1

2

PLATE 3.

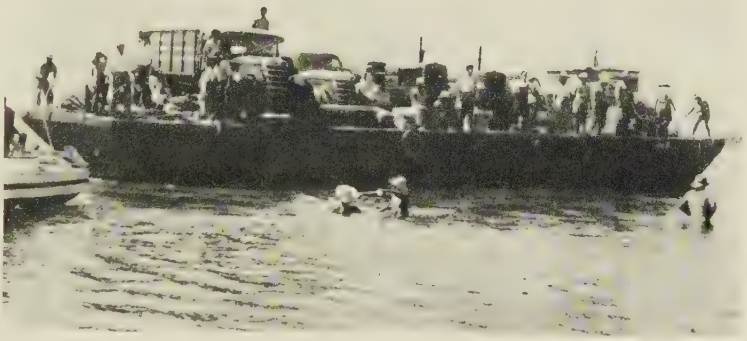


1

2

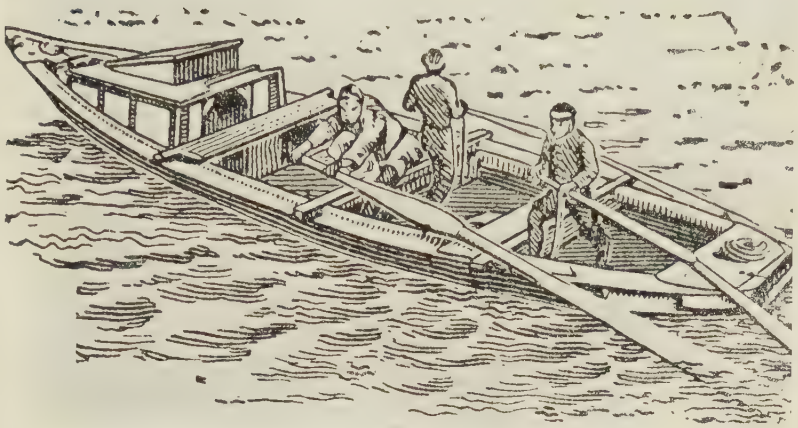
PLATE 4.

1



2

PLATE 5.



1

2

PLATE 6.

1

2

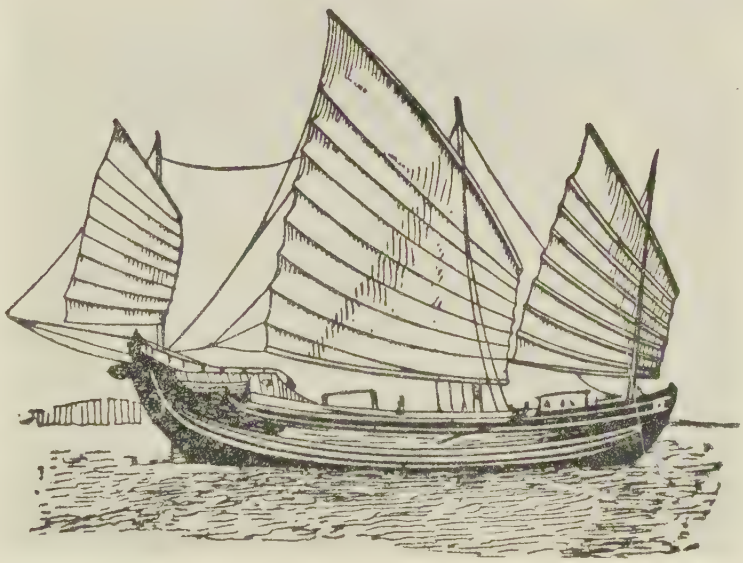
PLATE 7.

1

2

PLATE 8.

1



2

PLATE 9.

1

2

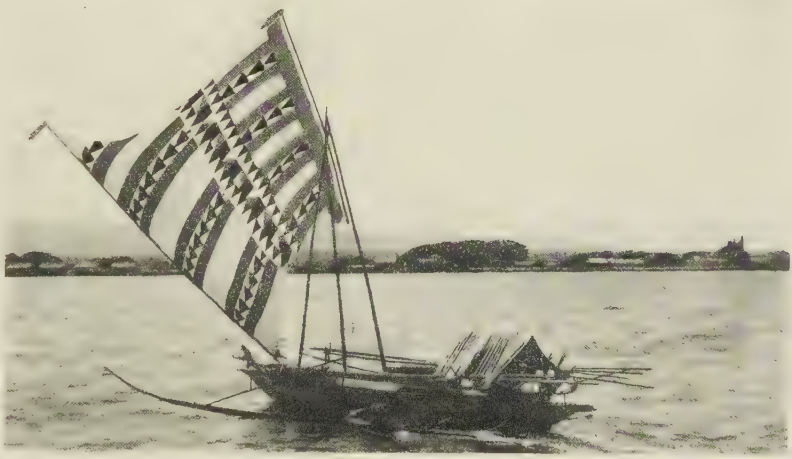
PLATE 10.

1

2

PLATE 11.

1



2

PLATE 12.

1

2

PLATE 13.

LABIDOCERA GLAUCA SP. NOV., A BLUE COPEPOD OF PUERTO GALERA BAY, MINDORO [1]

By Louise Victoria Smith

Of the Division of Fisheries
Department of Agriculture and Commerce, Manila

ONE PLATE AND SIX TEXT FIGURES

The writer is under obligation to Dr. Felix V. Santos, formerly of the Department of Zoology, University of the Philippines, for supervision of the work on which this report is based, and to Dr. Hilario A. Roxas, head of the same Department, for certain helpful suggestions in the research.

LABIDOCERA GLAUCA sp. nov. Plate 1.

Male.—Body laterally compressed, average length 3.2 mm; head evenly rounded, without side hooks but with a forked rostrum ending in strong rostral prongs. Length of head about ½ that of cephalothorax. Dorsal eye lenses cuticular and larger than in the female. Diameter of median ventral eye greater than that of dorsal eye. Cephalothorax divided into 7 segments. First two thoracic segments practically of equal size, but longer than any of the last four thoracic segments (Plate 1, fig. 1). Last thoracic segment symmetrical, fused with preceding segment and provided on each side with a lateral spine pointing posteriorly (Plate 1, fig. 2). Abdomen as long as head (Plate 1, fig. 1). Four abdominal segments bilaterally symmetrical. Furca also bilaterally symmetrical. Antenna asymmetrical, first left antenna composed of 23 segments reaching almost to base of furca. Many bristles covered with hairs present on outer side of antenna. Bristles decreasing toward terminal region. Hairs on inner side extending from about 1st segment to 13th. Segments of right antenna (grasping organ) fused to consist of 16 visible segments. Several fairly long bristles covered with hairs along inner side, bristles absent on outer side; sutured fold covering 11th and 12th visible seg-

[1] A portion of the thesis submitted to the Faculty of the University of the Philippines in partial fulfillment of the requirements for the degree of Master of Science in 1935.

ments on inner side; another sutured area covering about $\frac{2}{4}$ of 13th portion of two segments preceding terminal segment, generally provided with 5 sets of terminal spines (Plate 1, fig. 4). Thick left swimming leg (often referred to as swimming foot) 4-jointed, without endopodite. Terminal segment provided with 4 bristles at end, with numerous, thickly set hairs on inner surface. Terminal spine on second distal segment (Plate 1, fig. 10). Head segment of right 5th leg with proximal internally directed pronglike extension, terminal segment slender, recurved, terminating in a pronglike portion with one median and one terminal spine (Plate 1, fig. 11).

Female.—Average length of female approximately 3.5 mm (Plate 1, fig. 12). Female differs from male in: (*a*) Eyes generally smaller and never as close together as sometimes found in the male; last thoracic segment produced on either side to a rounded lobe and provided with a spine placed asymmetrically on side of segment (Plate 1, fig. 15). (*b*) Abdomen consisting of 2 segments, genital segment much larger than anal and provided with a lateral lobe on left side where genital opening is situated. (*c*) Anal segment twice as wide as long; furca symmetrical (Plate 1, fig. 14). (*d*) Antennæ similar to the left antenna of the male and reaching almost to the posterior border of the genital segment (Plate 1, fig. 15). (*e*) Sides provided each with 3 lateral, 1 terminal, and 1 median spine. A very small 4th lateral spine proximal to the terminal spine present in some specimens on left side, in others on right.

Light blue in life; colorless in 80 per cent alcohol.

Labidocera glauca, commonly known as the blue copepod, differs from Wheeler's(30) description of the genus *Labidocera* in two respects: (1) Wheeler describes this genus as possessing 5 segments in the cephalothorax, while the specimen under consideration has 7 segments; (2) the abdomen of the male *Labidocera* as described by Wheeler possesses 5 segments, while the Puerto Galera specimen has only 4 segments. The latter is in conformity with Lubbock's description.(19)

ECOLOGY

During April and May of 1933 and 1934 ecological studies were conducted at the Marine Biological Station of the University of the Philippines, Puerto Galera, Mindoro. The major problem involved was the determination of the diurnal vertical migrations of plankton, particularly *L. glauca*, to the surface of

the water. Special emphasis also was placed on the sex ratio of *L. glauca.*

A path to be followed on the collecting trips was laid out in a cove at Puerto Galera Bay. A definite point suitable for the lowering of the plankton net into the water was chosen at about 5 meters from the shore at the landing place. The turning point was a spot approximately 300 meters from the landing.

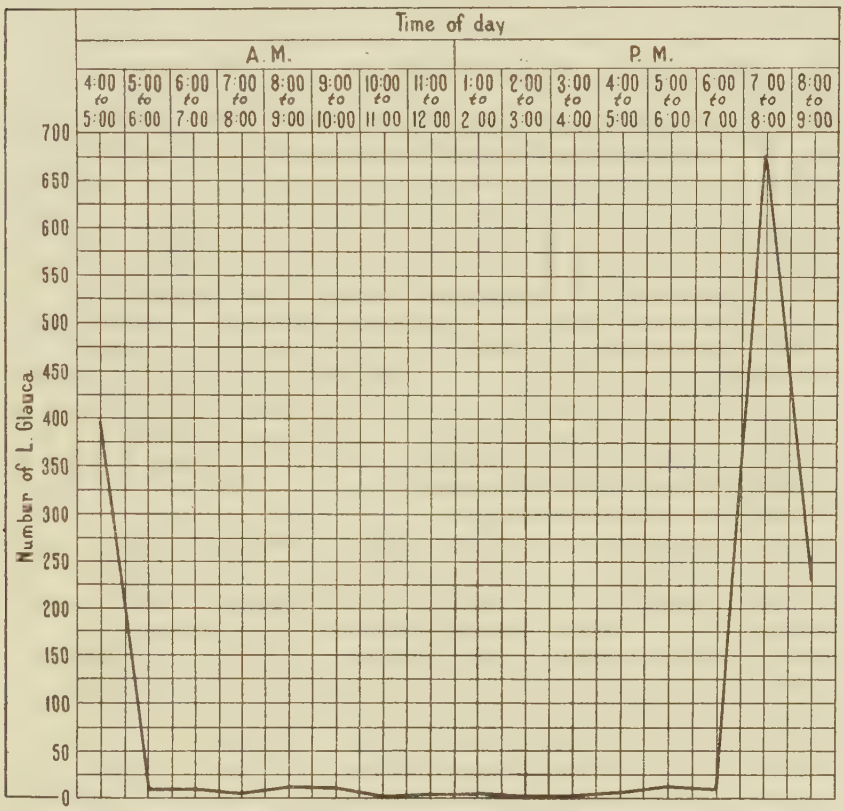


FIG. 1. Average numbber of *L. glauca* according to time of day. Based on Table 1.

The path was retraced on the return trip and the net raised at the place where it was lowered. A No. 17 plankton net was employed. The data obtained on these trips are given in Tables 1 to 5.

L. glauca come to the surface of the water after 4 A. M. and remain until about 5 A. M., after which they soon disappear and appear again after 7 P. M. (text figs. 1 and 2). These migrations to the surface during darkness, and the apparent

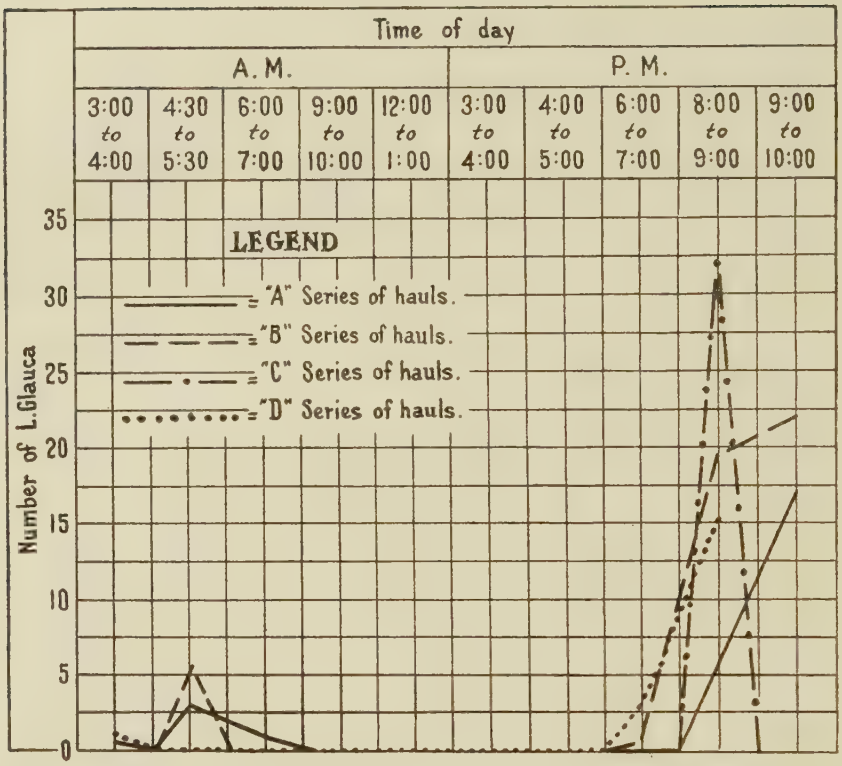


FIG. 2. Average number of *L. glauca* according to time of day. Based on Tables 2 to 5.

TABLE 1.—*Number of L. glauca and amount of plankton according to time of day (1933).*

Haul No.	Time.	Date.	Water temperature.	Number of *L. glauca* per haul.			Plankton.
				Total.	Male.	Female.	
	A. M.						cc.
1	4:25-4:35	May 6	27.3	393	206	187	9.0
2	5:45- 6:00	May 2	26.6	11	10	1	16.5
3	6:10- 6:25	April 19	27.2	10	3	7	10.5
4	7:00- 7:15	May 4	27.2	5	2	3	14.5
5	8:00- 8:15	April 5	26.5	[a] 16			10.5
6	9:15- 9:32	April 6	26.4	[a] 9			6.5
7	10:00-10:15	April 18	27.2	[a] 0			6.5
8	11:08-11:20	April 5	25.1	[a] 2			5.0
	P. M.						
9	1:07- 1:20	April 6	27.0	[a] 3			5.0
10	2:10- 2:25	April 8	27.2	[a] 0			5.5
11	3:06- 3:20	April 4	26.8	0			9.0
12	4:05- 4:22	April 6	27.0	5	2	3	9.0
13	5:03- 5:15	April 5	26.5	11			6.0
14	6:03- 6:15	April 6	27.4	10	2	8	6.0
15	7:08- 7:21	May 4		675	378	297	42.0
16	8:10- 8:25	April 21	27.8	228	143	85	21.0

[a] Sex not recorded.

TABLE 2.—*Record of hauls made with the tide receding, series A.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female.	
	A. M.		*feet.*			°C.						*cc.*
1	4:30– 4:47	May 4	1.0	transition	calm	26.5	[a]	sunrise	3	2	1	2.1
2	6:46– 6:57	April 21	1.4	weak daylight	do	26.0	8.4	misty	1	0	1	0.0
3	9:08– 9:20	April 25	3.0	medium day light	slight waves	28.0	[a]	cloudy	0			[b]1.0
	P. M.											
4	12:20–12:29	April 30	3.3	intense daylight	do	29.5	8.4	blue sky	0			0.5
5	3:10– 3:21	April 21	3.9	medium daylight	wind on calm	27.3	8.4	cloudy	[a]			17.4
6	4:08– 4:18	April 20	3.6	weak daylight	calm	27.3	8.4	overcast	[a]			[b]50.0
7	6:21– 6:32	April 21	2.4	transition	slight waves	27.0	8.4	sunset	[a]			[b]21.2
8	6:23– 6:35	May 4	1.9	do	do	27.5	[a]	do	[a]			7.0
9	8:57– 9:11	do	0.7	after sunset	do	27.0	[a]	dark	19	13	6	8.0
10	8:04– 8:08	April 20	0.3	do	wind on calm	26.4	[a]	half moon	10	5	5	34.0
11	8:09– 8:19	May 8	3.0	do	calm	28.5	[a]	dark	6	6	0	3.0
								Total	39	26	13	163.2

[a] No determination.

[b] Much algæ.

TABLE 3.—*Record of hauls made with the tide receding, series B.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female.	
	A. M.		*feet.*			°C.						*cc.*
1	4:56– 5:11	May 4	1.0	transition	calm	26.5	[a]	sunrise	8	5	3	4.5
2	9:23– 9:41	April 25	3.0	medium daylight	slight waves	28.0	[a]	cloudy	0	0	0	1.0
	P. M.											
3	12:33–12:43	April 30	3.3	intense daylight	do	29.5	8.4	blue sky	0	0	0	0.4
4	3:26– 3:38	April 21	3.9	medium daylight	wind on calm	27.3	8.4	cloudy	0	0	0	[b] 13.6
5	4:24– 4:34	April 20	3.6	weak daylight	calm	27.3	8.4	overcast		0	0	[b] 50.5
6	6:37– 6:47	April 21	2.4	transition	slight waves	27.0	[a]	sunset	0	0	0	23.5
7	6:38– 6:51	May 4	1.9	do	do	27.5	[a]	do	2	1	1	5.0
8	8:13– 9:23	do	0.6	after sunset	do	27.0	[a]	dark	22	15	7	6.5
9	8:18– 8:26	April 20	0.3	do	wind on calm	26.4	[a]	half moon	30	21	9	43.0
10	8:23– 8:34	May 8	3.0	do	calm	28.5	[a]	dark	8	5	3	3.5
								Total	70	47	23	148.5

[a] No determination.

[b] Much algæ.

TABLE 4.—*Record of hauls made with the tide rising, series C.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female.	
	A. M.		*feet.*			°*C.*						*cc.*
1	4:56– 5:08	April 24	1.0	transition	calm	27.5	8.4	sunrise	0			2.0
2	6:07– 6:18	April 27	1.8	weak daylight	slight waves	27.5	8.4	blue sky	0			0.8
3	9:06– 9:16	April 20	1.6	medium daylight	calm	27.4	8.4	cloudy	0			[a] 50.0
	P. M.											
4	12:08 12:18	April 23	1.9	intense daylight	slight waves	28.5	8.4	blue sky	0			5.7
5	3:05– 3:14	April 23	2.5	medium daylight	do	28.7	8.4	do	0			5.0
6	4:05– 4:16	April 24	2.9	weak daylight	do	29.0		do	0			10.0
7	6:30– 6:47	April 26	1.6	transition	calm	29.0	8.4	sunset	0			2.0
8	8:49– 9:00	April 30	3.0	after sunset	slight waves	28.0	8.4	full moon	31	20	11	4.0
9	8:30– 8:42	April 26	1.0	do	do	28.5	8.4	half moon	33	16	17	2.5
	A. M.											
10	3:33– 3:47	May 8	1.2	do	calm	28.2	8.4	full moon	1	0	1	1.0
11	3:20– 3:33	May 10	1.2	do	do	28.0	8.4	starlight	1	0	1	0.3
								Total	66	36	30	83.3

[a] Much algæ.

TABLE 5.—*Record of hauls made with the tide rising, series D.*

Haul No.	Time.	Date.	Tide.	Light.	Surface of water.	Temperature of water.	pH of water.	Sky.	Number of *L. glauca* per haul.			Plankton.
									Total.	Male.	Female	
	A. M.		*feet.*			°C.						*cc.*
1	5:12– 5:25	April 24	1.0	transition	calm	27.3	8.4	sunrise	0			2.0
2	6:22– 6:34	April 27	1.8	weak daylight	slight waves	27.5	8.4	blue sky	0			0.7
3	9:20– 9:34	April 20	1.6	medium daylight	calm	26.4	8.4	cloudy	0			[a]39.0
	P. M.											
4	12:22–12:30	April 23	1.9	intense light	slight waves	28.5	8.4	blue sky	0			6.0
5	3:18– 3:27	do	2.5	medium daylight	do	28.7	8.4	blue sky	0			5.3
6	4:20– 4:30	April 24	2.9	weak daylight	do	29.0	8.4	do	0			4.5
7	6:51– 7:01	April 26	1.6	transition	calm	29.0	8.4	sunset	3	1	2	3.0
8	9:05– 9:17	April 30	3.0	after sunset	slight waves	28.0	8.4	full moon	6	5	1	2.5
9	8:44– 8:57	April 26	1.0	do	do	28.5	8.4	half moon	15	8	7	3.0
	A. M.											
10	3:52– 4:09	May 8	1.2	do	calm	28.2	8.4	full moon	1	0	1	0.5
11	3:40– 3:52	May 10	1.2	do	do	28.0	8.4	starlight	0			0.1
								Total	25	14	11	84.6

[a] Much algæ.

absence of this copepod during daylight, tend to prove that *L. glauca* are negatively phototropic. However, the fact that very few were found on the surface between 2:30 and 4 A. M. indicates that other factors are involved. The factors of temperature, pH, and condition of the surface of the water, height and direction of the tide, and condition of the sky were all found to

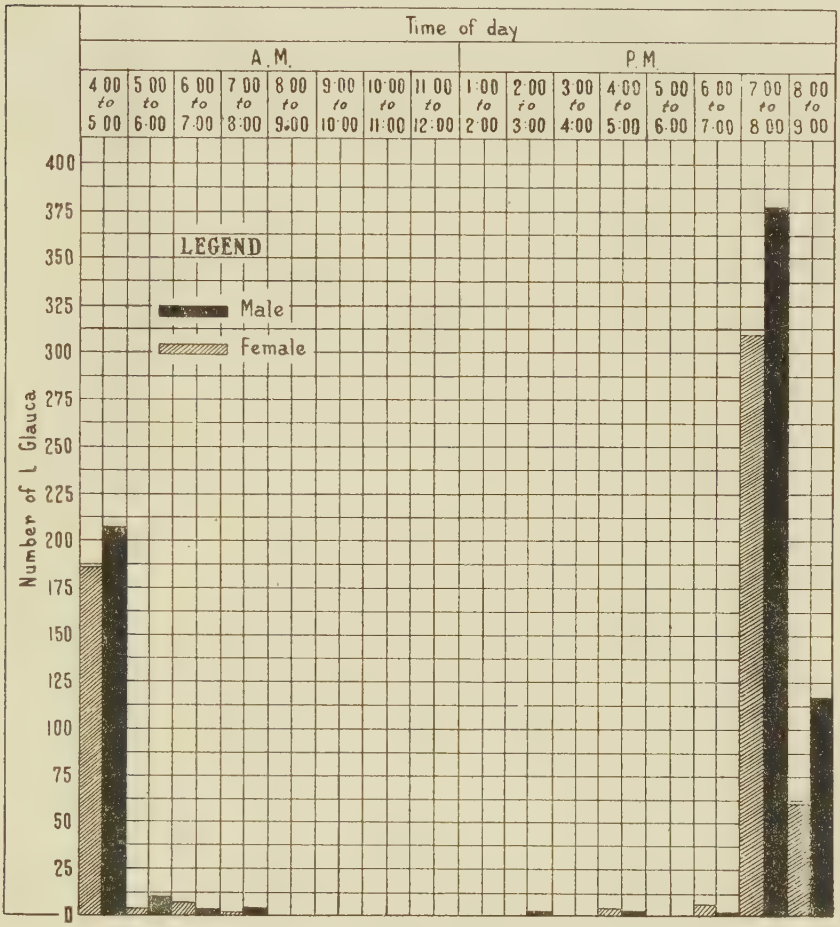


FIG. 3. Number and sex ratio of *L. glauca* according to time of day. Based on Table 1.

have insignificant bearing on the problem at hand. The writer's contention is then that *L. glauca* is negatively phototropic, since very few individuals are ever found on the surface of the water during daylight, although they do not remain on the surface during the entire period of darkness. They must descend some time between 9:30 P. M. and 2:30 A. M. and ascend again at 4

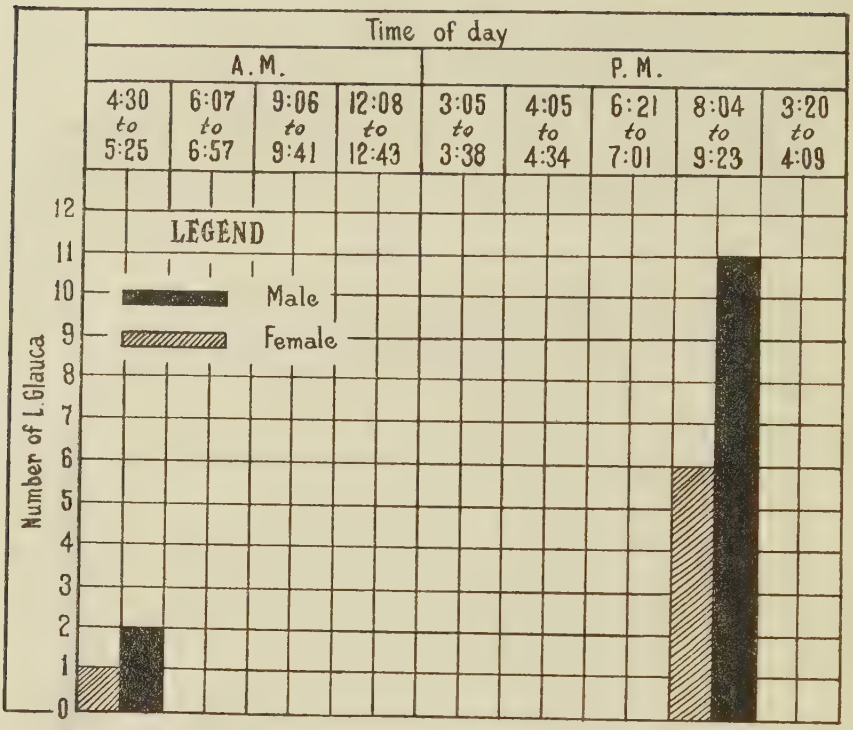


FIG. 4. Number of sex ratio of *L. glauca* according to time of day. Based on Tables 2 to 5.

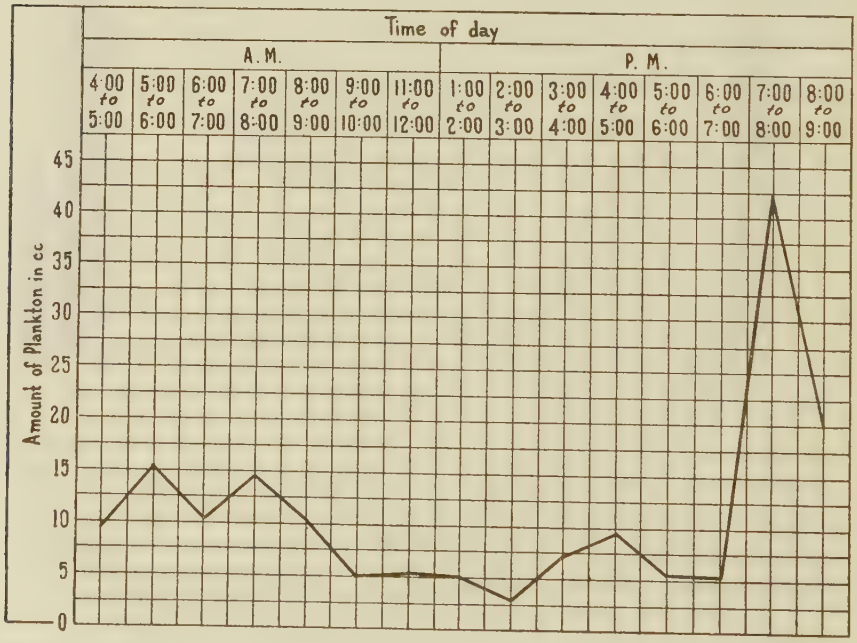


FIG. 5. Average amount of plankton according to time of day. Based on Table 1.

A. M. Whether or not *L. glauca* migrate to the surface between 9:30 P. M. and 2:30 A. M. was not determined in this investigation.

As to sex ratio, the males outnumbered the females in all of the migrations to the surface for both years (text figs. 3 and 4). In 1934 (text. fig. 4) the males had a greater preponderance over the females in the evening surface migrations than during 1933 (text fig. 3). The fact, however, that a comparatively large number of females do come to the surface with the males appears to indicate that both sexes have similar migratory habits.

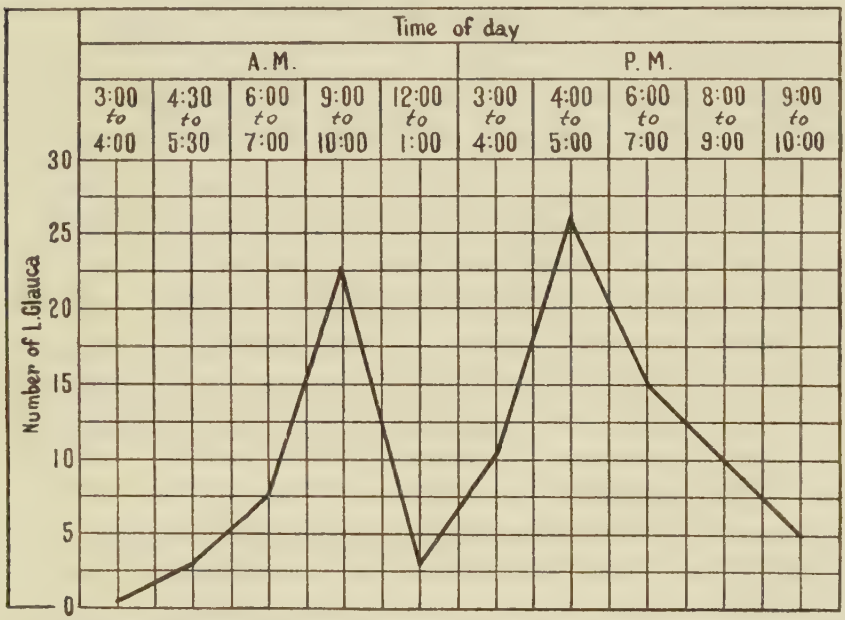


FIG. 6. Average amount of plankton according to time of day. Based on Tables 2 to 5.

There seemed to be no agreement according to the time of day between the average bulk of plankton (excluding *L. glauca*) collected during 1933 and that collected during 1934. Nor did there appear to be any correlation between the number of *L. glauca* and the average amount of plankton collected (text figs. 5 and 6).

REFERENCES

1. BRADY, G. S. Marine copepod of New Zealand. Trans. Zool. Soc. 15 (1832) 31–54.
2. CLARKE, G. I. Factors affecting the vertical distribution of copepods. Ecological monographs (4) 4 (1934) 530–540.

3. CHUN, C. Die pelagische Thierwelt in grossen Meerestiefen und ihre Beziehungen zu der Oberflächenfauna. Bibliotheca Zoologica 1 (1887) 1–66.
4. ESTERLY, G. O. The pelagic copepoda of the San Diego Region. Univ. Cal. Publ. Zool. 2 (1905–1906) 113–234.
5. ESTERLY, G. O. Additions to the copepod fauna of the San Diego Region. Univ. Cal. Publ. Zool. 3 (1906–1907) 53–92.
6. ESTERLY, G. O. The occurrence and vertical distribution of the Copepoda of the San Diego Region. Univ. of California Pub. Zool. 9 (1912) 253–340.
7. ESTERLY, G. O. Reactions of various plankton animals with reference to their diurnal migrations. Univ. Cal. Publ. Zool. 19 (1919) 1–83.
8. EWALD, W. F. Ueber Orientisierung, Lokomotion, und Lichtreaktionen einiger Cladoceren und deren Bedeutung fur die Theorie der Tropismen. Biol. Centralbl. 30 (1910) 1–16, 49–63, 379–384.
9. EWALD, W. F. On the artificial modification of light reactions and the influence of electrolytes on phototaxis. Journ. Exp. Zool. 13 (1912) 591–611.
10. FOWLER, G. H. Biscayan plankton—methods and data. Trans. Linn. Soc. Zoology 10 (1909) 1–11.
11. FRANZ, V. Weitere Phototaxisstudien: I. Zur Phototaxis bei Fischen. II. Phototaxis bei marinen Crustaceen. III. Phototaktische Lokomotionsperioden bei Hemimysis. Intern. Rev. Hydrobiol. U. Hydrogr. d. biol. Supp. XXXI (1911) 1–23.
12. GARDINER, A. C. Vertical Distribution in Calanus finmarchius. Journ. Mar. Biol. Assoc. n. s. 2 (1932–1933) 575–611.
13. GISBRECHT, W., and O. SCHMEIL. Das Tierreich—Crustacea—Acarina —Arachnidea (1898) 131–139.
14. GROOM, T. T., and J. LOEB. Der Heliotropismus der Nauplien von Balanus perforatus und die periodischen Tiefenwanderungen pelagischer Tiere. Biol. Centralbl. 10 (1890) 160–177.
15. HARMER, S. F., and A. E. SHIPLEY. Cambridge Natural History 4 (1909) 55–79.
16. HARPER, E. H. The behavior of the phantom-larvae of Corethra plumicornis Fabricius. Journ. Comp. Neurol. and Psychol. 17 (1907) 435–456.
17. HERDMAN, W. A., I. C. THOMPSON, and A. SCOTT. On the plankton collected continuously during two traverses of the North Atlantic in the summer of 1897, with descriptions of new species of Copepoda, and an appendix on dredging in Puget Sound. Trans. of Liverpool Biol. Soc. 12 (1897) 33–91.
18. KENZO, KIKUCHI. A Comparison of the diurnal migration of plankton in eight Japanese lakes. Mem. Coll. Sci. Kyoto Imperial Univ. ser. B art. 3 (1) 5 (1930) 27–75.
19. LUBBOCK, J. Description of a new genus of Calanidae. Ann. Nat. Hist. II 11, 12 (1853) 25–29.
20. LUBBOCK, J. On two new subgenera of Calanidae. Ann. Nat. Hist. II 11, 12 (1853) 202–210.
21. MENKE, H. Periodische Bewegungen und ihr Zusammenhang mit Licht und Stoffwechsel. Arch. Ges. Physiol. 140 (1911) 37–91.

22. MICHAEL, E. F. Classification and vertical distribution of the Chaetognatha of the San Diego region, including redescriptions of some doubtful species of the group. Univ. Calif. Pub. Zool. 8 (1911) 21–186.
23. PARKER, G. H. Reactions of copepods to various stimuli and the bearing of this on daily depth migrations. Bull. U. S. Fish. Com. 21 (1901) 103–123.
24. PECK, J. I. On the food of menhaden. Bull. U. S. Fish Com. for 1893 (1894) 351–368.
25. RUSSEL, F. S. The vertical migration of marine macroplankton. An observation on diurnal changes. Journ. Mas. Biol. Assoc. n. s. (4) 13 (1925) 769.
26. RUSSELL, F. S. The vertical distribution of marine macroplankton. Notes on the behavior of Sagitta in the Plymouth area. Journ. Mas. Biol. Assoc. n. s. 17 (1930) 391–405.
27. SCOTT, A. The Copepoda of the Siboga Expedition. Siboga Expeditie 44 (1909) 164–170.
28. SCOTT, T. Report on the Entomostraca of the Gulf of Guinea, collected by J. Rattray. B. Sc. Trans. Linnean Soc. II (Zool.) 6 (1893) 1–162.
29. THOMPSON, I. C. Revised report on the Copepoda of Liverpool Bay. Trans. Liverpool Biol. Soc. 7 (1893) 175–230.
30. WHEELER, W. M. Free swimming Copepoda of Woods Hole Region. Bull. U. S. Fish Com. 19 (1899) 157–193.
31. WILSON, C. B. The copepod plankton of the last cruise of the non-magnetic ship Carnegie—The Collecting Net. Sat. (Sept. 2, 1933) 1.
32. YERKES, R. M. Reactions of Entomostraca to stimulation by light. Am. Journ. Physiol. 3 (1899) 157–182.

ILLUSTRATIONS

PLATE 1. *Labidocera glauca* sp. nov.; × 50.

FIG. 1. Male; right lateral view.
2. Male, last thoracic segment; dorsal view.
3. Male, abdomen; dorsal view.
4. Male, first right antenna; right lateral view.
5. Male, second right antenna; right lateral view.
6. Male, right mandible and palp; anterior view.
7. Male, maxilla.
8. Male, second maxilla.
9. Male, maxilliped.
10. Male, 5th left leg.
11. Male, 5th right leg.
12. Female; lateral view.
13. Female, last thoracic segment.
14. Female, abdomen; dorsal view.
15. Female, first left antenna; dorsal view.
16. Female, first right leg; right lateral view.
17. Female, second right leg; right lateral view.
18. Female, third left leg; left lateral view.
19. Female, fourth right leg; right lateral view.
20. Female, fifth pair of legs; ventral view.

TEXT FIGURES

[Drawn by Francisco Rafael]

FIG. 1. Average number of *L. glauca* according to time of day. Based on Table 1.
2. Average number of *L. glauca* according to time of day. Based on Tables 2 to 5.
3. Number and sex ratio of *L. glauca* according to time of day. Based Table 1.
4. Number and sex ratio of *L. glauca* according to time of day. Based on Tables 2 to 5.
5. Average amount of plankton according to time of day. Based on Table 1.
6. Average amount of plankton according to time of day. Based on Tables 2 to 5.

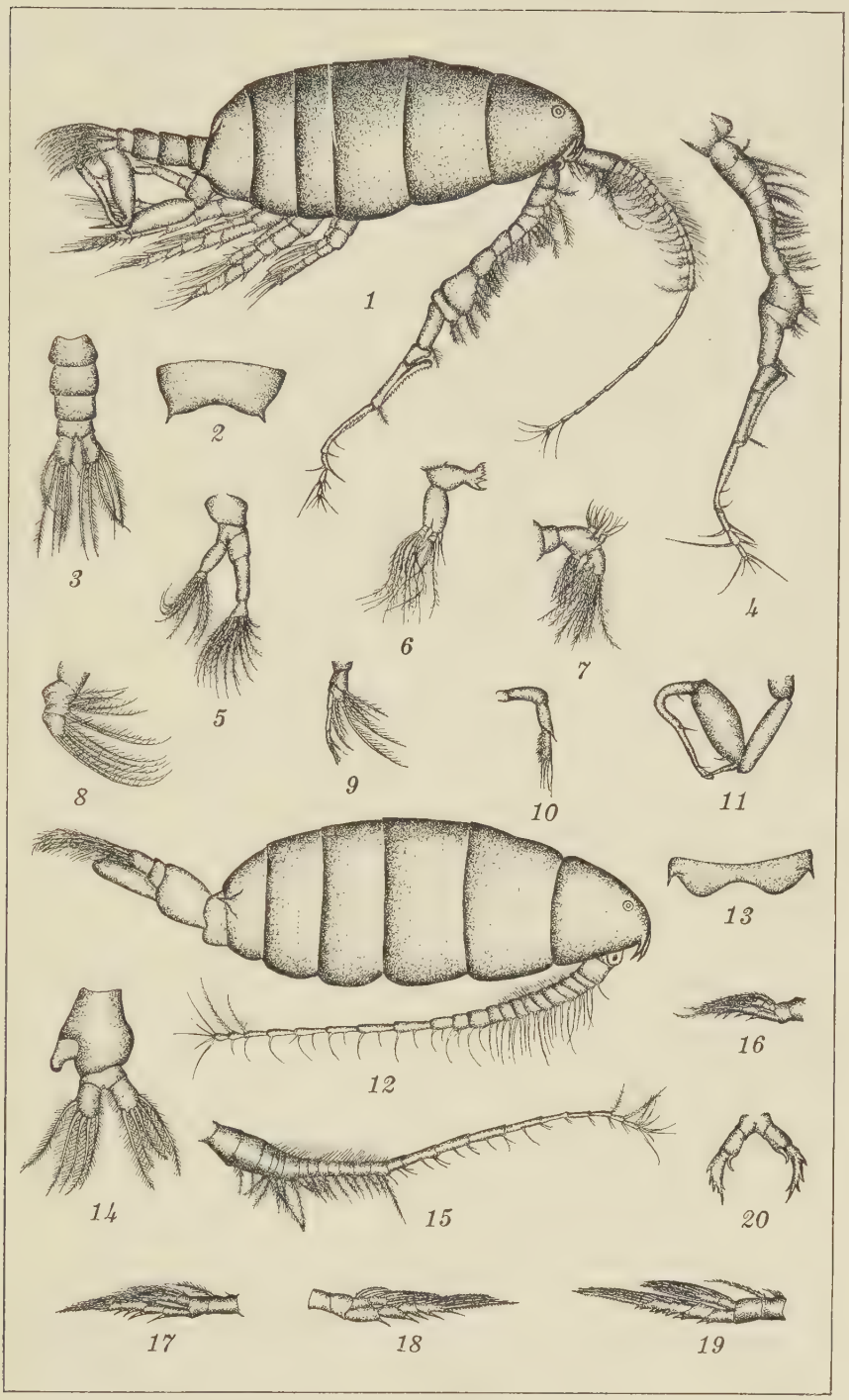


PLATE 1. LABIDOCERA GLAUCA SP. NOV.

BLATTODEA FROM LOS BAÑOS, LUZON, PHILIPPINES

By G. Bey-Bienko

Of the Leningrad Agricultural Institute, Leningrad, USSR

SIX TEXT FIGURES

The present paper is based on a small collection of Blattodea made by Mr. N. Ikonnikov in the vicinity of Los Baños, Luzon, Philippines, in 1917, and submitted to me for study some years ago by Mr. A. Zhelokhovzev from the Zoological Institute of Moscow University.

The types of all new species are deposited in the Zoological Institute of Moscow University.

ECTOBIINÆ

Genus MARETA Bolivar

MARETA SUBCONTIGUA sp. nov. Text fig. 1.

Luzon, Laguna Province, Los Baños, April 25, 1917, 1 female (type) ; May 15, 1 female; May 22, 1 male? (abdomen missing) (*N. Ikonnikov*).

Very similar to *M. contigua* Walker from New Guinea, Malay Archipelago, Malay Peninsula, and Siam, in the presence of the porcelain-white crossbar on the head just above the antennal sockets, in the unusually long cerci, and in the presence of five branches on the anterior cubital vein (CuA) of the hind wings, but differs from it chiefly in the presence of numerous, somewhat elevated and plainly visible small dark-brown spots on the principal veins of elytra. Interocular space nearly equal to width between antennal sockets. Coloration of head brownish testaceous, with porcelain crossbar as described above; maxillary palpi very long, third and fourth joints very slender, subequal in length, fifth joint almost three-fifths as long as fourth. Pronotum with two pairs of brown dots on middle before hind margin (of which the anterior pair is much more approximated than posterior pair), two elongated, irregular, brown markings in median part, and two widely separated brown dots a little behind median markings. Elytra with numerous dots as described above, pale testaceous, extending a little beyond apex of cerci; R with fifteen oblique branches of which four or five apical

branches are forked; mediocubital (discoidal) field with indistinctly oblique, practically longitudinal sectors. Wings with costal part pale testaceous; Sc with three thickened oblique branches, R with two thickened proximal branches, radiomedian field equal in width to mediocubital field, CuA with five regular branches, apical triangle narrow but distinct. Abdomen darkened above, testaceous below, very small, indistinct, dark lateral spots on the ventral surface of each segment. Supraanal plate strongly transverse, median part moderately produced, with a

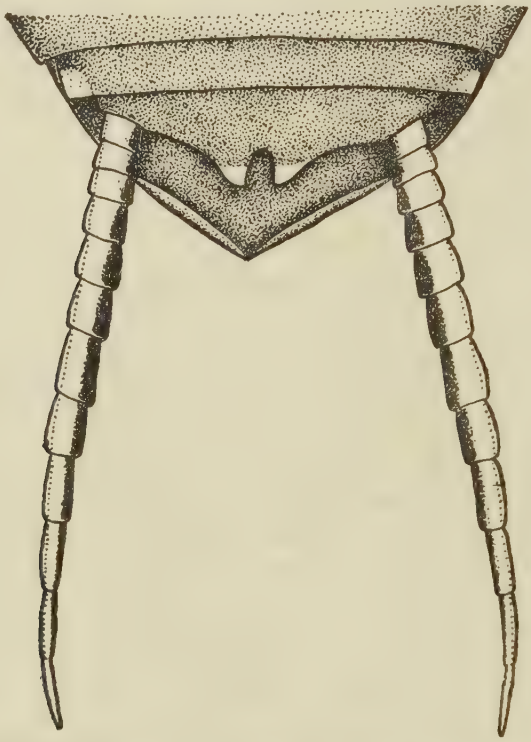


FIG. 1. *Mareta subcontigua* sp. nov.; apex of abdomen of female type, dorsal view.

deep emargination so that the plate is bilobate; apex of each lobe pale, the rest of plate dark brown. Cerci very long and slender, with fourteen joints, apical joint subspiniform, not thicker than apical antennal joints; lower surface of cerci dirty testaceous, inner margin of upper surface blackened. Legs testaceous, fourth and apex of third joints of all tarsi blackened above. Anterior lower margin of anterior femora armed with a long row of pyliform spines, terminating in two large distal spines.

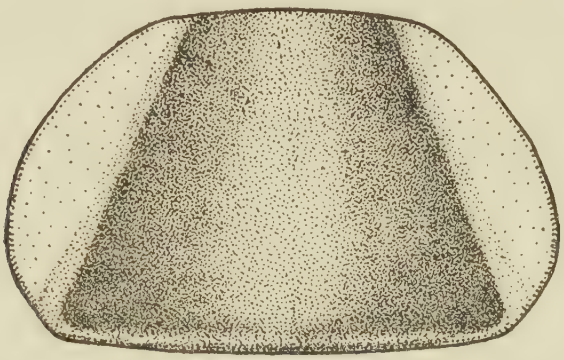
Female.—Length of body 11.2 to 11.6 millimeters; pronotum 2.8; elytra 12.5; cerci 4.3 to 4.5; total length 15.5.

The present species shows a distinct affinity to some species of the related but independent genus *Grabtoblatta* Hebard, viz. *G. testacea* Hebard and *G. nodosa* Fritze, being characterized by the same general appearance, proportions of maxillary palpi, and even by the similar structure of the supraanal plate.

MARETA LUZONICA sp. nov. Text fig. 2.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 male (*N. Ikonnikov*).

A small species with very distinctive coloration of pronotum. General color testaceous. Face of head testaceous; upper part just above antennal sockets with a very broad porcelain-white crossbar partly occupying the lower part of vertex; upper part



PIG. 2. *Mareta luzonica* sp. nov.; pronotum of male type.

of latter brown, interocular space relatively broad, equal in length to third joint of maxillary palpi (other joints broken off); antennæ pale. Pronotum transverse, one and one-half times as broad as long, anterior and posterior margins practically straight; disc with a large, reddish-brown, trapezoidal spot, strongly broadening posteriorly, lateral margins of spot darker than median part, bordered with a narrow white line; lateral parts of pronotum hyaline. Elytra slightly narrowing apically, moderately extending beyond apex of abdomen, pale testaceous, without dark spots, veins and veinlets slightly whitish and opaque, producing a very delicate tesselation, basal part with a whitish stripe between Sc and R and with a narrower, dark-brown, bow-shaped stripe between basal fourth of R and M, oblique branches of R fourteen. Abdomen testaceous be-

low, with a small lateral brownish spot on each segment; supra-anal plate broadly triangular, short, apex slightly deflexed, with very feeble excision. Subgenital plate symmetrical, with a broad angular excision in middle, inner margin of each lobe straight, slightly reflexed, forming a narrow marginal rim; styli very small, subconical, a little longer than wide at base, placed on apex of each lobe. Cerci unicolorous, testaceous. Legs testaceous, typical for the genus.

Length of body 9 millimeters; pronotum 2; elytra 8.3; total length 10.3.

MARETA (?) DIAMESA sp. nov. Text fig. 3.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 male (*N. Ikonnikov*).

Very similar in general habitus and coloration to *Grabtoblatta testacea* Hebard from Java, but characterized by oblique sectors in the mediocubital field of elytra and therefore not congeneric

FIG. 3. *Mareta* (?) *diamesa* sp. nov.; anterior femur of male type.

with that species. On the other hand the new species is characterized by type C armament of anterior femora, but the apical part of the anterior lower margin of these femora is armed with three spines instead of two, as in typical members of the genus *Mareta*.

Body unicolorous, pale. Head pale testaceous, without transverse band between eyes or antennal sockets, with very distinct convex ocellar spots; interspace between eyes equal in length to interspace between antennal sockets. Maxillary palpi with third and fourth joints normal, not elongated, fourth joint a little longer than third (fifth joint broken off). Pronotum irregularly pentagonal, one and a half times as broad as long, central part pale testaceous, immaculate, lateral parts hyaline. Elytra unicolorous, hyaline, extending beyond apex of abdomen at a distance twice as great as pronotal length, veins and veinlets slightly whitish and opaque, giving a very delicate reticulation (visible under magnification only). Mediocubital (discoidal) field with moderately oblique sectors. Abdomen pale testaceous, without dark spots near lateral margins of ventral surface.

Supraanal plate very short, strongly transverse, with moderately rounded hind margin. Subgenital plate symmetrical, with triangular excision in middle; styles moderately depressed, directed backwards, about twice as long as broad at base, moderately narrowing apically, but its immediate apex not sharpened; apex of each lobe of plate slightly produced in the shape of a very short, rounded lobule. Cerci pale testaceous. Legs pale testaceous, anterior lower margin of anterior femora armed with pyliform spinules only (type C), apex with three spines, of which the first spine is very short but distinct; other features typical for the genus.

Length of body 9.5 millimeters; pronotum 2.7; elytra 11.5; total length 13.5.

The systematic position of this species is intermediate between the genera *Mareta* and *Grabtoblatta*, although the principal morphological features (structure of the maxillary palpi, disposition of the sectors in the mediocubital field of elytra, and type C armament of the anterior lower margin of the anterior femora) are identical with those in the genus *Mareta*. The present species differs from the typical *Mareta* only in the presence of three, instead of two, apical spines on the anterior femora. *Grabtoblatta testacea* Hebard also widely differs from the typical members of the genus *Grabtoblatta* in the presence of a single large spine in the median part of the anterior lower margin of the anterior femora, whereas the genotype (*G. notulata*) is characterized by two or three median spines. On the other hand, the above described *Mareta subcontigua* sp. nov. is also characterized by somewhat intermediate characteristics and shows distinct affinity to *G. testacea* and *G. nodosa*. It is evident therefore that a revision of the entire group is badly needed.

Genus ALLACTINA Hebard

ALLACTINA JAKOBSONI Hebard.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female.

Originally described from Fort de Kock, Sumatra,(5) but subsequently recorded from northern Australia and Borneo,(4) Celebes,(2) Pahang, and Singapore;(1) the present record extends its area further northward.

ALLACTINA IKONNIKOVI sp. nov. Text. fig. 4.

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 male (*N. Ikonnikov*).

Head brownish yellow, with pale-yellow vertex, eyes moderately separated, interspace between them on vertex equal to interspace between antennal sockets and to fourth joint of maxillary palpi; maxillary palpi testaceous, slender, fifth joint moderately thickened, slightly shorter than fourth, the latter a little shorter than third. Antennæ black. Pronotum one and one-half times as broad as long, anterior and posterior margins slightly rounded, practically straight, disc with the center pale whitish, with two broad, longitudinal, brownish-black bands, fused behind and forming a broad ring open in front, median area with longitudinal, X-shaped, blackish-brown marking, pale-whitish border on anterior and posterior margins of pronotum of equal width, lateral parts of pronotum narrowly transparent. Scutellum black, with a whitish median triangular stripe. Elytra moderately narrowing apically, brownish, except marginal and anterior part of costoradial fields which are discolored; all veins and veinlets whitish, forming a very dense reticulation, apex of elytra roundish angular. Wings infumate, with costal margin reddish yellow; intercalated triangle very distinct. Abdomen reddish testaceous above and below, upper surface with indistinct brownish band along lateral margins. Supraanal plate strongly transverse, broadly triangular, slightly excised on middle. Subgenital plate symmetrical, with a relatively narrow triangular excision, hind margin of each lobe transverse, bearing a short, practically spherical stylus, placed at the angle between hind and external margins of the lobe. Cerci relatively long and slender, reddish testaceous. Legs testaceous, structure typical for the genus.

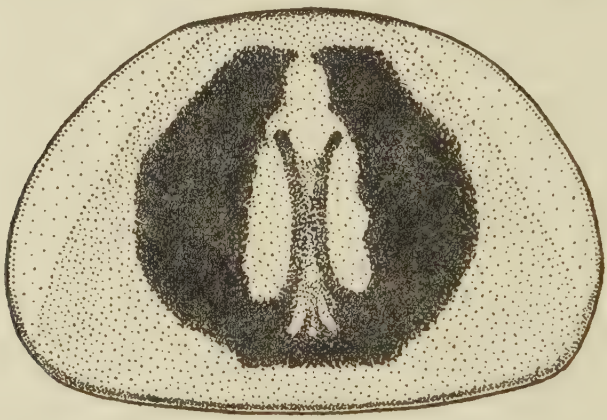


FIG. 4. *Allactina ikonnikovi* sp. nov.; pronotum of male type.

Length of body about 10 millimeters; pronotum 2.2; elytra 11; total length 12.6.

The pale-yellow vertex and the dense whitish reticulation on the elytra make this species easy to recognize.

Genus GRABTOBLATTA Hebard

GRABTOBLATTA NITULATA (Stål).

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 male.

A widely distributed species but previously unknown from the Philippines.

Genus PACHNEPTERYX Brunner

A very distinctive Philippine genus belonging to the subfamily Ectobiinæ. Shelford(6) includes it in the subfamily Phyllodromiinæ (Pseudomopinæ of recent authors) but probably without actual study of the genotype, *Pachnepteryx pruinosa* Brunner.

The genus was imperfectly known and a redescription is given below to supply a satisfactory definition.

Antennæ strongly plumose in both sexes. Head broadly triangular, sides strongly convergent toward mouth parts, distinctly concave just below eyes which are somewhat produced sidewise; maxillary palpi not elongate, fifth joint moderately broadened, equal in length to third and slightly longer than fourth. Pronotum scarcely broader than long, with a large black spot. Elytra corneous, with obscured venation, mediocubital field with longitudinal sectors. Wings with distinct but not broad apical triangle, oblique branches of Sc and R moderately thickened, CuA with only two complete incurved branches. Anterior lower margin of anterior femora armed with an elongate row of pyliform spinules (type C), terminating in two large distal spines, lower margins of other femora sparsely armed with delicate spines; tarsi with small pulvillus on each of four joints, tarsal claws moderately asymmetrical, simple, arolia large. Supraanal plate strongly transverse, in male moderately produced, with rounded hind margin, in female with very distinct, narrowly triangular excision in middle; subgenital plate in male asymmetrical, irregularly divided by a deep and narrow excision into two asymmetrical projections, without true styli.

Genotype: *Pachnepteryx pruinosa* Brunner.

PACHNEPTERYX PRUINOSA Brunner.

LUZON, Laguna Province, Los Baños, May 5 to 15, 1917, 3 males and 2 females.

From the material at hand the following additional diagnostic features of this species are drawn. Antennæ in female thicker than in male, with two light, broad bands, one of which is whitish and placed at the apex of the widest part, the second reddish yellow and placed in the apical half (apex of antennæ in male missing). Hind margin of pronotum with a narrow black border. Basal part of all coxæ black. Abdomen black above, with a narrow, reddish, lateral border, lower surface black, sides reddish, hind margins of sternites bordered with bluish or whitish; last sternite in female black, lateral part reddish; subgenital plate in male reddish, dextral process longer than sinistral.

Male, length of body 8 to 9.2 millimeters; pronotum 2 to 2.2; elytra 8.3 to 9.2; total length 10.3 to 11.5.

Female, length of body 8.5 to 8.8 millimeters; pronotum 2.3; elytra 8 to 8.6; total length 10 to 11.4.

Genus PACHNEBLATTA novum

Allied to *Pachnepteryx* but differing as follows: Body much broader. Pronotum distinctly transverse, about one and one-third as broad as long. Anterior lower margin of anterior femora armed with two or three long median spines, succeeded by a row of minute pyliform spinules, and terminating in three long distal spines; tarsal claws slightly unequal, practically symmetrical.

Genotype: *Pachnepteryx signaticollis* Stål.

To the same genus belongs *Pachnepteryx pallidicollis* Stål and probably *P. ventralis* Walker.

PACHNEBLATTA SIGNATICOLLIS (Stal).

LUZON, Laguna Province, Los Baños, April 5, 1917, 1 female; April 15, 1 male and 1 female.

Stål(8) in his description of *Pachnepteryx signaticollis* indicates the female sex, but Sjöstedt(7) has shown that the type specimen belongs to the male sex; after Sjöstedt's correction the identification of the species on the basis of Stål's short description is not difficult.

A short redescription of the species from the specimens before me and a description of the hitherto unknown male seems desirable.

Antennæ in female with a broad whitish band at middle, in male probably unicolorous, black (antennæ in male specimen partly missing). Head dirty reddish in male, face blackened

in female; vertex in female testaceous, in male reddish yellow, occiput with three black (female) or reddish-brown (male), median longitudinal stripes, median stripe much broader and subdivided into two stripes; three basal joints of maxillary palpi pale, somewhat tinged with brown, two apical joints black. Pronotum with a large, rounded, pale spot on disc, bordered with bluish or whitish, and including a very distinct design in reddish brown (male) or blackish (female), containing three narrow, median, longitudinal stripes and many irregular symmetrically arranged spots and stripes; hind margin of pronotum with very narrow dirty-reddish, sometimes indistinct border, lateral parts transparent. Elytra piceous, with very dense, small, whitish points, marginal field and anterior margin of elytra subhyaline. Wings infumate. Lower surface of abdomen in male reddish yellow, in female brownish, with reddish lateral spots, hind margin of sternites bordered with bluish. Supra-anal plate strongly transverse, in male with moderately rounded hind margin, in female with median part produced and triangularly excised. Subgenital plate in male with a deep median excision, dextral part with a long projection, which is narrowed apically and bears an irregular, indistinctly separated stylus, sinistral part very short, with a short styliform projection. cerci relatively short, in male reddish yellow, in female black. Legs in male pale testaceous, in female blackened at bases of coxæ, upper surface, femora, tibiæ, and tarsi; spines pale.

Male, length of body 8 millimeters; pronotum 2.5; elytra 10.2; total length 12.3.

Female, length of body 9 to 9.5 millimeters; pronotum 2.3 to 2.5; elytra 9.6 to 10; total length 12.

Genus MARGATTEA Shelford

MARGATTEA INVALIDA sp. nov. Text fig. 5.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 male (*N. Ikonnikov*).

A slender, contrastingly colored species. Head unicolorous, pale testaceous, with very distinct, pale, ocellar spots, interspace between eyes relatively broad, equal to interspace between antennal sockets, maxillary palpi concolorous, not elongate, fifth joint moderately broadened, subequal in length to fourth, fourth joint slightly shorter than third. Antennæ one and one-half times as long as body, black on entire length, except for two basal joints and upper part of third joint which are pale testaceous, and a

narrow stripe on sixth to eighth joints which is brownish. Pronotum transverse, one and one half times as broad as long, anterior margin slightly rounded, posterior margin between shoulders straight; disc reddish testaceous, with feeble reddish tinge, without dark stripes or spots, lateral parts hyaline. Elytra extending far beyond apex of abdomen, slightly narrowing apically, R distinctly sinuate in basal half, with fourteen or fifteen oblique branches, some apical branches forked, mediocubital field with very slightly oblique, practically longitudinal sectors; coloration dark brown with a broad but apically narrowing pale

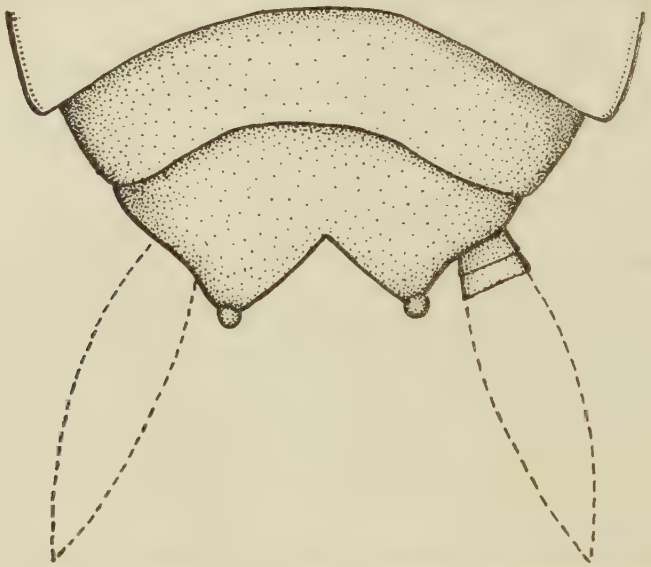


FIG. 5. *Margattea invalida* sp. nov.; apex of abdomen of male type, ventral view.

border along costal margin. Wings infumate, with pale-testaceous border along costal margin. Abdomen reddish testaceous below, tinged with brown above; supraanal plate strongly transverse, hind margin obtusely angulate; subgenital plate symmetrical, with a profound rectangular emargination in middle, each lobe triangular, with very short, practically spherical stylus on apex (basal part of cerci pale testaceous, other part broken off). Legs testaceous, anterior lower margin of anterior femora with a single, relatively small median spine, succeeded by a long row of pyliform spinules terminating in two large distal spines, genicular spines on the median and posterior femora long, slightly longer than fourth joint of maxillary palpi; spines of lower

margins of median and posterior femora not numerous, relatively long, delicate.

Length of body 8.1 millimeters; pronotum 2.1; elytra 9.3; total length 10.8.

A distinctive species easily recognized by its coloration and by the presence of a single, elongate, median spine on the anterior lower margin of the anterior femora.

PSEUDOMOPINÆ

Genus BLATTELLA Caudell

BLATTELLA LITURICOLLIS Walker.

LUZON, Laguna Province, Los Baños, May 25, 1917, 1 female.

A widely distributed species; hitherto not recorded from the Philippines. The specimen agrees well with a typical series from southeastern China.

Genus PARASYMPLOCE Hebard

PARASYMPLOCE MARGINALIS Hanitsch?

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female.

The arrangement of the fulvous border of the pronotum agrees with the description of Hanitsch(3) for *P. marginalis* from the Malay Peninsula, but the disc of the pronotum is brownish piceous.

Head brownish ferrugineous, unicolorous; basal part of antennæ dirty testaceous, blackish toward apex. Pronotum with pale-fulvous border on the lateral and anterior margins, disc brownish piceous. Elytra extending beyond apex of abdomen at a distance equal to pronotal length; coloration castaneous, marginal field pale fulvous; R forked slightly before its middle, with nineteen oblique, simple branches. Wings infumate. Abdomen pale testaceous below, with a pair of lateral brown spots on each segment; supraanal plate broadly triangular, apex with a shallow angular excision. Cerci pale fulvous above, tinged with brown below. Legs testaceous, typical for the genus.

Length of body 13 millimeters; pronotum 3.3; elytra 12.7; total length 16.5.

EPILAMPRINÆ

Genus EPILAMPRA Burmeister

EPILAMPRA CYRTOPHTHALMA Stål?

LUZON, Laguna Province, Los Baños, May 22, 1917, 1 female.

Stål's(8) description is very short and vague.

The present specimen is characterized as follows: Coloration flavotestaceous. Interocular-ocellar region and occiput with dense brown points and some less numerous and larger spots, eyes wide apart, interspace between them a little narrower than interspace between antennal sockets and about twice as great as width of an eye on anterior part of head. Antennæ ferruginous. Pronotum with dense ferruginous points, but without longitudinal stripes before hind margin. Elytra with irregular ferruginous fine borders along actual and false veins; R with some irregular dark-brown spots on basal half. Lower surface of abdomen with relatively dense, ferruginous points and spots but without black lateral spots, cerci pale testaceous, with extreme apex blackened; supraanal plate roundly triangular, with a deep acute-angulate median excision. Bases of tibial spines, apical parts of all tibiæ and of tarsal joints blackened, anterior lower margin of anterior femora with four median and one apical spines and one intermediate series of small spinules, hind margin with four stout spines, hind metatarsus equal in length to remaining joints.

Length of body 24 millimeters; pronotum 5.9; elytra 22; total length 28.5.

EPILAMPRA LUZONICA sp. nov. Text fig. 6.

LUZON, Laguna Province, Los Baños, May 22, 1917, 2 males (including type) and 1 female (*N. Ikonnikov*).

Male pale testaceous, female much darker, brownish testaceous. Head distinctly depressed anteriorly; interocular space with a black band, quite flat, seen in profile forming with occiput a very distinct angle, in male relatively narrow, nearly twice as broad as width of an ocellus, interspace between antennal sockets about twice as broad as interocular space; in female interocular space broader, about three times as broad as width of an ocellus, interspace between antennal sockets only one and one-half times as broad as interocular space; maxillary palpi short, all three apical joints subequal in length, fifth joint slightly darkened. Antennæ blackish brown, except some basal joints which are pale. Pronotum a little less than one and one-half times as broad as long, anterior margin slightly rounded, lateral portions obtuse-angulate, hind margin bisinuate, with median part roundly produced; surface without marked depression, covered with dense reddish (in male) or blackish-brown (in female) spots, hind part with four longitudinal stripes of same coloration on the produced median part. Elytra in male sur-

passing apex of abdomen at a distance subequal to pronotal length, in female at a distance equal to one-half pronotal length; coloration in male pale testaceous, with indistinct and sparse reddish spots. Sc whitish pale; coloration of elytra in female pale greenish, with more distinct and more numerous reddish-brown spots. Wings testaceous along costal margin, cinereous in other part. Abdomen pale, lower surface with a pair of black spots on each segment, placed along lateral margin, and with sparse, blackish-brown points. Supraanal plate hyaline, with hind margin semicircular, in male with a feeble, shallow, obtuse, median emargination, in female with deeper, acute-angulate ex-

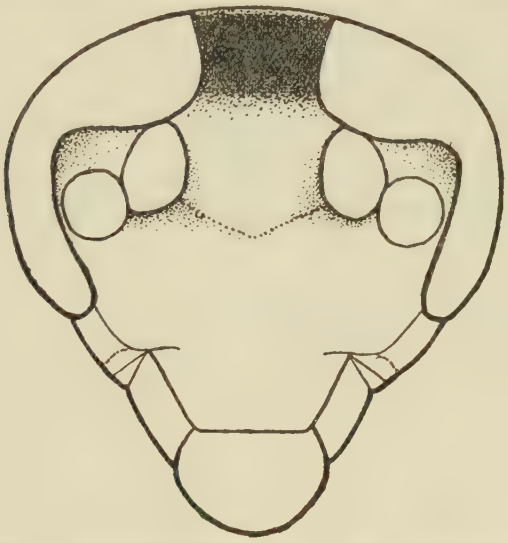


FIG. 6. *Epilampra luzonica* sp. nov.; head of male type.

cision in middle; subgenital plate of male hyaline, transverse, symmetrical, with two very delicate styli, hind margin obtusely angulate, cerci pale, relatively short. Legs pale, anterior coxæ with black basal spot and less sharp, brownish (male) or brownish-black (female) median spot, tarsi slightly darkened; all femora in female with darkened upper margin; anterior lower margin of anterior femora with three or four median spines, a single apical spine and an intermediate series of small spinules; hind metatarsus equal in length to remaining tarsal joints.

Male, length of body 18 millimeters; pronotum 4 to 4.2; elytra 17; total length 21.5 to 22.

Female, length of body 23 millimeters; pronotum 5.2; elytra 21; total length 27.

The present species may be easily distinguished by the structure and coloration of the head.

LITERATURE CITED

1. HANITSCH, R. Fauna Sumatrensis. Blattidæ. Tijdschr. voor Entom. 80 (1929) 263–302.
2. HANITSCH, R. The blattid fauna of Celebes, based chiefly on the collections made by P. and F. Sarasin. Verh. Naturforsch. Ges. Basel 44 (1933) 119–150.
3. HANITSCH, R. The Blattidæ of Mount Kinabalu, British North Borneo. Journ. Feder. Malay States Museum pt. 2 17 (1933) 297–337.
4. HANITSCH, R. Blattids from Java and northern Australia. Rev. Suisse Zool. 41 (1934) 111–130.
5. HEBARD, M. Studies in Malayan Blattidae (Orthoptera). Proc. Acad. Nat. Sci. Philad. 81 (1929) 1–109, 6 pls.
6. SHELFORD, R. Genera Insectorum fasc. 73. Orthoptera, Blattidæ, Phyllodromiinæ. (1908) 29 pp., 2 pls.
7. SJÖSTEDT, Y. Orthopterentypen im Naturhistorischen Reichsmuseum zu Stockholm. 6. Blattidae. Arkiv för Zool. A (15) 25 (1933) 1–17.
8. STÅL, C. Orthoptera nova ex Insulis Philippinis. Ofvers. Kongl. Vetensk.-Akad. Förhandl. No. 10 (1877) 33–58 [Blattina pp. 33–57].

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Mareta subcontigua* sp. nov.; apex of abdomen of female type, dorsal view.
2. *Mareta luzonica* sp. nov.; pronotum of male type.
3. *Mareta (?) diamesa* sp. nov.; anterior femur of male type.
4. *Allactina ikonnikovi* sp. nov.; pronotum of male type.
5. *Margattea invalida* sp. nov.; apex of abdomen of male type, ventral view.
6. *Epilampra luzonica* sp. nov.; head of male type.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Knowing Your Trees. By G. H. Collingwood. Washington, D. C., The American Forestry Association, 1940. Fourth printing. 109 pp., illus. Price, $1.

This book presents to the reading public information concerning the life, habitat, and characteristics of each tree, together with the botanical features, uses, economic importance, and other details that distinguish one tree from another. The language is easily understood, as the use of technical terms has been avoided wherever possible. The book gives descriptions of fifty trees belonging to the most commonly known coniferous and broad-leafed species of the United States. The discussion of each tree is supplemented by photographs showing the leaves, fruit, bark, and frequently one of the blossoms. The condition of the twigs of the deciduous broad-leafed trees during winter and summer are also shown. The natural range of each species is shown on an outline map of the United States.

This book is recommended to students, botanists, foresters, and lay persons interested in trees. A selected bibliography is found at the end of the discussion. An index of common and scientific names facilitates the use of the book.—P. D.

Kingdom of the Trees. By Erle Kauffman. Chicago, The Reilly and Lee Company, 1940. 122 pp., illus. Price, $2.

This book is intended particularly for the boys and girls of America. It is written in the form of a story, being narrated by an old forester to two children. The author has made the book interesting by using the trees as characters. Anecdotes, stories, and tales are skillfully woven into the narration of the life of the trees, their importance, requirements for growth, and service to humanity. Among the trees mentioned by the author are the elm as "The Tree of Glory", the maples as the "Tree Farmers" producing sugar, the fir and holly as Christmas trees,

and trees linked with great Americans. Among the trees of the forest there are "farmers, doctors, teachers, loafers and kings."

It is a book that will greatly help a teacher in his class in nature study, and in arousing interest among children in the proper care and regard for the trees about them. It contains many beautiful illustrations. At the end of the book is a table which serves as a guide in the identification of the trees mentioned in the text.—P. D.

The Home Book of Trees and Shrubs. By J. J. Levison. New York, Simon and Schuster, Inc., 1940. 424 pp. Price, $5.

This book is a record of some of the lessons the author has gleaned from his mistakes, experiments, and experiences during the last three decades of active service as forester in charge of the parks and street trees of Brooklyn and New York City, and as consultant to hundreds of private estates and institutions. It is written in a popular style, so that laymen or amateur gardeners can obtain from it authentic simple information on the necessity of having a definite plan for the home grounds; important considerations in selecting planting materials; best trees and shrubs for various sites and locations and their care; determination of what every tree needs and how to supply it; pruning, repair, and protection of trees and shrubs; common insect pests and diseases, and how to control them; determination of the need for a wooded portion of the home grounds, its care, maintenance, and improvement; planning, establishment, fertilizing, seeding, and care of lawns; use, selection, and arrangement, of flowering plants; and the selection of accessories, like garden furniture and shelters, fences, tennis courts, and the like, which should be not only attractive, but also suited to the environment.

Descriptions are given of typical gardens and popular misconceptions and fallacies about trees and shrubs for home ground planting, supplemented with photographs of views of different portions of the garden.

As an aid in the selection of trees for planting on suburban and country home grounds the author classifies the trees under four headings; namely, deciduous trees of the large-growing kind, deciduous trees of the small-growing species, large evergreen trees, and small evergreen trees. A list is given of the trees arranged in the order of preference.

A working program for every month of the year is presented. The author has found this system helpful in handling the numerous estates in his charge as consultant.

Of interest to the florist is a list of flowers, showing the color, full period and time of blooming, height of the plant, distance of planting, perennial, biennial, or annual varieties, light and soil requirements, and other information, as on cut flowers, easily grown flowers, flowers hard to keep, and so on.

The book contains information which every one interested in beautiful home grounds should have as a ready reference. The photographs of homes and various kinds of gardens are inspiring. Insect pests, diseases, individual trees, methods of planting, and many other topics are illustrated in the text.—P. D.

The New York Hospital Handbook of Applied Nutrition. Published by the New York Hospital. New York, 1939. 136 pp., front., illus.

This booklet contains menus recommended for the different meals of the day for patients under different conditions of treatment in the hospital. The amounts of the various items are given in grams as well as in terms of common household units of measurement. The total caloric value, the calories for fats, carbohydrates, and proteins are given for each group of 24-hour menus. A special feature of the booklet are the simplified standards for caloric requirement for total energy, fats, carbohydrates, and proteins which are given per kilogram of body weight, so that a general diet recommendation may be made without going through complicated computations. There are appended the usual tables of compositions of single foods, vitamin charts, and age-height-weight tables.

This handbook is a necessary addition to every hospital library.—N. C.

Mineral Metabolism. By Alfred T. Shohl. New York, Reinhold Publishing Corporation, 1939. 384 pp. Price, $5.

This comprehensive, up-to-date review of the rôle played by each of the different inorganic salts in various metabolic processes gives a detailed description not only of the mineral composition of the body, but also of the inorganic contents of secretions, excretions, and endocrines, and the changes observed in the mineral economy under various abnormal conditions such as dehydration, diabetes insipidus, Addison's disease, and parathyroid disturbances.

Particular emphasis is devoted to the metabolism of calcium, phosphorus, iron, and iodine, whose absorption, intermediary metabolism, and excretion have been carefully described. The pages on ricketts, tetanus, hypochromic anæmias, and goitre are illuminating. Finally, the mineral intake and mineral require-

ments at various ages and conditions are taken up, together with a description and critique of the general procedures used in mineral balance studies.—J. S. Jr.

Vitamin E. A Symposium Held Under the Auspices of the Food Group (Nutrition Panel) of the Society of Chemical Industry on Saturday April, 22, 1939, at the School of Hygiene and Tropical Medicine, London, England. New York, Chemical Publishing Co., Inc., 1940. 88 pp., illus. Price, $2.

This symposium is an excellent presentation of a combination of publications by researchers and clinicians in the basic medical sciences. The book is divided into three parts; namely, chemistry of tocopherol or vitamin E; physiologic action of vitamin E and pathology of avitaminosis–E; and clinical application of vitamin E therapy.

Vitamin E can be isolated from wheat-germ oil as crystalline alcohols; namely, A and B-tocopherol. A-tocopherol has the formula $C_{29}H_5O_2$, and is active in rats at a dose of 2 to 3 milligrams. B-tocopherol has the formula $C_{28}H_{48}O_2$, and is active at a dose of about 5 milligrams. γ-tocopherol, isomeric with and of the same biologic activity as B-tocopherol, has been isolated from cottonseed oil. Biologic activity is dependent on the length of the aliphatic side chain and on the number of methyl groups in the tocopherol molecule; a long side chain and the presence of three methyl groups being most favorable in A-tocopherol. Quantitative chemical tests for the vitamin are given.

Prominent effects of E deficiency in rats are gestation resorption in females and slow degeneration of spermatogenic tissue in males. Other effects are discoloration of uterus and seminal vesicles, paralysis of hind limbs, skin sores, emaciation, and death. Attempts have been made to explain the underlying pathogenesis of the above defects. Some authors believe that vitamin E deficiency is a simple pituitary deficiency. Others call attention to the possibility of pituitary hormone inbalance in vitamin E deficiency. Some workers suggest that the vitamin acts directly on the gonads and thereby indirectly affects the pituitary. Studies are given showing that placental transfer of vitamin E in rats is negligible, while maternal (mammary) transfer is very limited. A bioassay of the vitamin is described.

The clinical application of vitamin E therapy was first tried in 1931, nine years after the discovery of the vitamin in the therapy of frequent, noninfectious barrenness (sterility and abortion) in cows in Denmark with 75 per cent of 1,200 animals

becoming pregnant. P. Vogt-Moller reported two series in man, one of 20 and the other of 52 cases, of habitual abortion in which no anatomical, physiological, or pathological abnormalities could explain the condition. Administration of wheat-germ oil (3 grams daily) resulted in the birth of living children in 17 and 38 cases respectively. These women were subjected also to serological and hormone tests. Their husbands were found with normal spermatozoa. Evan Shute claims that vitamin E deficiency in women may be diagnosed by measuring the resistance of blood sera to proteolysis, in addition to clinical signs as a hypothyroid appearance, a small area of uterine tenderness localized in the placental site, hypertension, albuminuria, and termination of pregnancy before maturity with deformed infants. The usual dose recommended is 1 to 2 drams of wheat-germ oil daily or one 3-minim capsule of the concentrate of the oil equivalent to 6 milligrams tocopherol daily for about 18 weeks.—J. S. Jr.

Marihuana. America's New Drug Problem. A Sociologic Question With its Basic Explanation Dependent on Biologic and Medical Principles. By Robert P. Walton. With a Foreword by E. M. K. Geiling. Philadelphia, J. B. Lippincott Co., 1938. 223 pp., plates. Price, $3.

Dr. Robert P. Walton presents here in a scientific and systematic manner all available data on marihuana, which in recent years has become a deadly menace in the United States. This monograph gives the history of the marihuana vice and the countries affected by this drug habit, with particular reference to its present status in the United States. The source from which this drug is obtained, the method of administration and the experience of those who use it are described in this book.

Other topics discussed are the following: acute effects, chronic effects, therapeutic application, and pharmaceutical and chemical considerations relating to the drug.

Professor Walton states that his book is primarily a reference for those seeking information on this drug and the use of it.—A. O. C.

Field Trials: Their Lay-out and Statistical Analysis. By John Wishart. Cambridge, England, School of Agriculture, 1940. 36 pp. Price, paper 2s/6d.

This bulletin is a very handy reference for beginners in field experiments and much more so for plant breeders. The author wrote it as nearly as possible in nontechnical language, and whatever technical terms are used are defined. As an exposi-

tion of the method of laying out field trials and of the statistical analysis of the results, it contains an introduction to the measurement of experimental error, test of significance, method of randomized blocks, general method, method of the Latin square layout, multifactor experiments, split-pilot experiments, confounding, and experiments with a large number of varieties. It likewise serves as an introduction to the more complex problems of field experimental procedures and analysis of factorial experiments and to other books which give detailed methods on the subject. References for further reading are included in this bulletin.—M. S. S.

Electrocapillarity. By John Alfred Valentine Butler. New York, Chemical publishing Co., Inc., 1940. 208 pp., illus. Price, $5.

This book deals with the physical and chemical phenomena arising from differences of potentials at the surface of contact of electrified bodies. The subject is broad in scope, touching all points related to electrodes and other charged surfaces. It begins with the important discoveries made by Galvani and Volta, which later on became the object of further experimentations by various workers. In the chapters that followed, the different complicated problems regarding potential differences under different conditions, the points of views of various experimenters on their respective subjects bearing relation to potential differences, and the points of view of the author are amply discussed and illustrated.

Although the chemistry and physics of electrodes is not a new science, the subject as discussed in this book is interesting, not only because of the manner in which it is presented and developed but also because the problems treated have an important bearing on industry and biology. It is a valuable book, especially for those devoted to the study of electrochemical phenomena.—R. H. A.

Time and its reckoning. By R. Barnard Way and Noel D. Green. New York, Chemical Publishing Co., Inc., 1940. 137 pp., front., illus. Price, $2.

This is an essentially popular account of how time has been kept throughout the ages. Considerable useful knowledge is imparted in a clear and simple, though somewhat profuse way.

May we call attention, however, to a few defects or errors which, in case of a possible second edition, we hope to see corrected? On page 27, in speaking of the proposed reform of the

calendar, reference is made only to the thirteen-month scheme and not to the revision retaining twelve months which seems more in favor at present. On page 115, bottom line, the word "meridian" should be "latitude." The account of the new and very important quartz crystal chronometers should have been more ample. Finally, we hardly think that the very small and elementary chapter on the nature of time at the end of the book suffices to fulfill the promise made at the beginning to treat the metaphysical aspect of time.—C. E. D.

RECEIVED

A. S. T. M. Standards on textile materials. Prepared by Committee D–13 on textile materials. Specifications, tolerances, methods of testing, definitions and terms. October, 1940. Philadelphia, The Society, 1940. 368 pp., illus. Price, $2.

BOAS, FRANZ. Race, language and culture. New York, The Macmillan co., 1940. 647 pp., illus. Price, $5.

COLE, LEWIS GREGORY, and WILLIAM GREGORY COLE. Pneumoconiosis (silicosis); the story of dusty lungs, a preliminary report. New York, John B. Pierce Foundation, 1940. Separately paged, illus.

HIMES, NORMAN E., and others. Practical birth-control methods. New York, Modern age books, 1939. 254 pp., illus. Price, $1.49.

KESO, EDWARD E. Conserving our resources. Oklahoma City, Times-Journal publishing co., 1940. 206 pp., illus. Price, $0.98.

MAIRET, ETHEL M. Vegetable dyes. New York, Chemical publishing co., inc., 1939. 68 pp. Price, $2.

MATTHEWS, F. J. Boiler feed water treatment. 2d ed. rev. and enlarged. New York, Chemical publishing co., inc., 1939. 319 pp., illus., plates. Price, $5.

SNELL, FOSTER DEE, and CORNELIA T. SNELL. Chemicals of commerce. New York, D. Van Nostrand co., inc., 1939. 542 pp. Price, $5.

WAY, R. BARNARD, and NOEL D. GREEN. Time and its reckoning. New York, Chemical publishing co., inc., 1940. 137 pp., front., illus. Price, $2.

HALDANE, J. B. S. Science and everyday life. London, Lawrence and Wishart ltd., 1939. 284 pp. Price, 5s/—.

HUTTON, ISABEL EMSLIE. The hygiene of marriage. 8th ed. London, William Heinemann (Medical books) ltd., 1940. 152 pp., illus. Price, 5s/—.

KIRKENDALL, LESTER A. Sex adjustments of young men. New York, and London, Harper & brothers, 1940. 215 pp. Price, $2.

NEWELL, ADNAH CLIFTON. Coloring, finishing and painting wood. Peoria, Illinois, The Manual arts press, 1940. 480 pp., illus. Price, $4.50.

SKINKLE, JOHN H. Textile testing, physical, chemical and microscopical. New York, Chemical publishing co., inc., 1940. 272 pp., illus. Price, $3.

TAYLOR, F. SHERWOOD. Science front 1939. London, Toronto, Melbourne and Sydney, 1939. 301 pp., illus. Price, $2.50.

THE PHILIPPINE BUREAU OF SCIENCE

RECENT MONOGRAPHIC PUBLICATIONS

SUMMARY OF PHILIPPINE MARINE AND FRESH-WATER MOLLUSKS. By Leopoldo A. Faustino. Order No. 485. Bureau of Science Monograph 25. Paper, 384 pages. Price, $2 United States currency, postpaid.

SECOND TEN-YEAR INDEX TO THE PHILIPPINE JOURNAL OF SCIENCE, Volume 11 (1916) to Volume 28 (1925). By Winifred I. Kelly. Order No. 486. Bureau of Science Monograph 26. Paper, 381 pages. Price, $2 United States currency, postpaid.

THIRD TEN-YEAR INDEX TO THE PHILIPPINE JOURNAL OF SCIENCE, Volume 29 (1926) to Volume 58 (1935). By Sophie Rodolfo and Amando D. Singson. Philippine Department of Agriculture and Commerce Technical Bulletin 11. Paper, 432 pages. Price, $2.25 United States currency, postpaid.

FILTERABLE VIRUS AND RICKETTSIA DISEASES. By Earl Baldwin McKinley. Order No. 487. Bureau of Science Monograph 27. 442 pages, 70 plates, and 7 text figures. Prices, paper, $2.50; bound in full red keratol, $4, United States currency, postpaid.

EXPERIMENTAL STUDIES OF DENGUE. By James Stevens Simmons, Joe H. St. John, and Francois H. K. Reynolds. Order No. 489. Bureau of Science Monograph 29. Paper, 489 pages, 3 plates, and 159 text figures. Price, $3.50 United States currency, postpaid.

PHILIPPINE LAND MAMMALS. By Edward H. Taylor. Order No. 490 Bureau of Science Monograph 30. Paper, 548 pages, 25 plates and 25 text figures. Price, $2.50 United States currency, postpaid.

THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, Philippines.

Manuscripts on biology must be accompanied by abstracts for publication in the Biological Abstracts.

Fifty separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Division of Publications, Department of Agriculture and Commerce, post-office box 613, Manila, Philippines, or to any of the agents listed below.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Scientific Library, Bureau of Science, post-office box 774, Manila, Philippines.

AGENTS

The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbasi, Tori-Nichome, Tokyo, Japan.

CONTENTS

	Page
MANALO, GLORIA D., and AUGUSTUS P. WEST. Reducing the acidity of Manila Copal: Reaction of run copal and glycerol	233
JULIANO, JOSÉ B. Callus development in graft union	245
YUTUC, LOPE M. Studies on the influence of splenectomy on natural and acquired immunity of rats to Nippostrongylus muris	255
ALVIR, A. D. The origin of placer gold in Santa Maria River, Bulacan	279
ACENA, SERGIO P. Preliminary notes on a trematode with two yolk reservoirs and a new species of Lecithochirium	285
GALANG, RICARDO E. Types of watercraft in the Philippines	291
SMITH, LOUISE VICTORIA. Labidocera glauca sp. nov., a blue copepod of Puerto Galera Bay, Mindoro	307
BEY-BIENKO, G. Blattodea from Los Baños, Luzon, Philippines	323
BOOKS	339

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.